MECHANICAL ENGINEERING

February 1960

The Engineer in International Affairs, 54

Pump Standardization — A User's Concept, 57

Aircraft Seating — Forward Facing? . . . or Rearward? 60

The Manipulator: Its Design and Application, 64

New Tire-Reinforcing Materials, 76

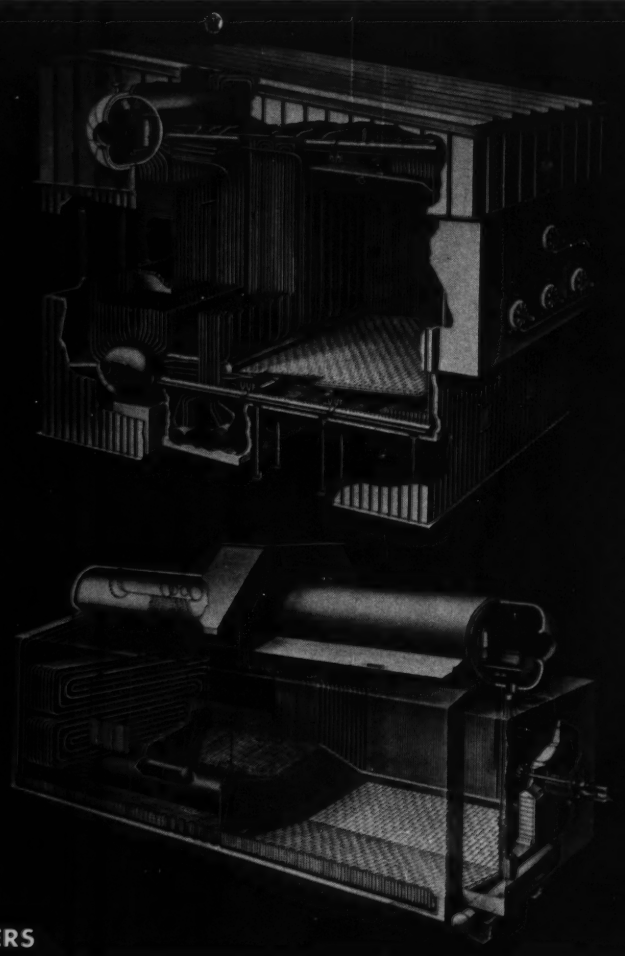
Turbine Bearing Design, 82

ANNUAL REVIEW
Progress in Railway Mechanical Engineering, 1958-1959, 68

Atomic Fuel-Element Assembly

B&W INTEGRAL-FURNACE BOILER, TYPE PFI—The PFI, B&W's new Integral-Furnace Boiler, produces steam in the general range of 80,000 to 400,000 pounds per hour. Oil or gas, or a combination of both, can be used as fuel. In power, process or heating applications, the pressure fired PFI assures clean, dependable steam over a wide load range. The drainable superheater, at left center, permits the draining of water after a shut down, facilitating easy storage and simple, safe start-up. Generous tube spacing prevents ash or slag plugging of the superheater. The burners at extreme right are centralized for easy observation and adjustment, while the integral combustion air duct at the top of the unit saves space.

B&W INTEGRAL-FURNACE BOILER — TYPE FO — B&W's new package boiler offers economy, convenience and quality at capacities from 60,000 to over 100,000 pounds per hour. A natural circulation boiler, the FO combines the advantages of the package boiler with the proved reliability of B&W Integral-Furnace design. The FO Boiler has a completely water-cooled furnace of ample volume, and is designed to provide steam at pressures from 250 to 775 psi at temperatures up to 750 F.



B&W INTEGRAL-FURNACE BOILERS
. . . range in size from shop assembled "package" units (5,000 to 100,000 lb hr) to field erected units for capacities up to 400,000 lb hr.

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B&W

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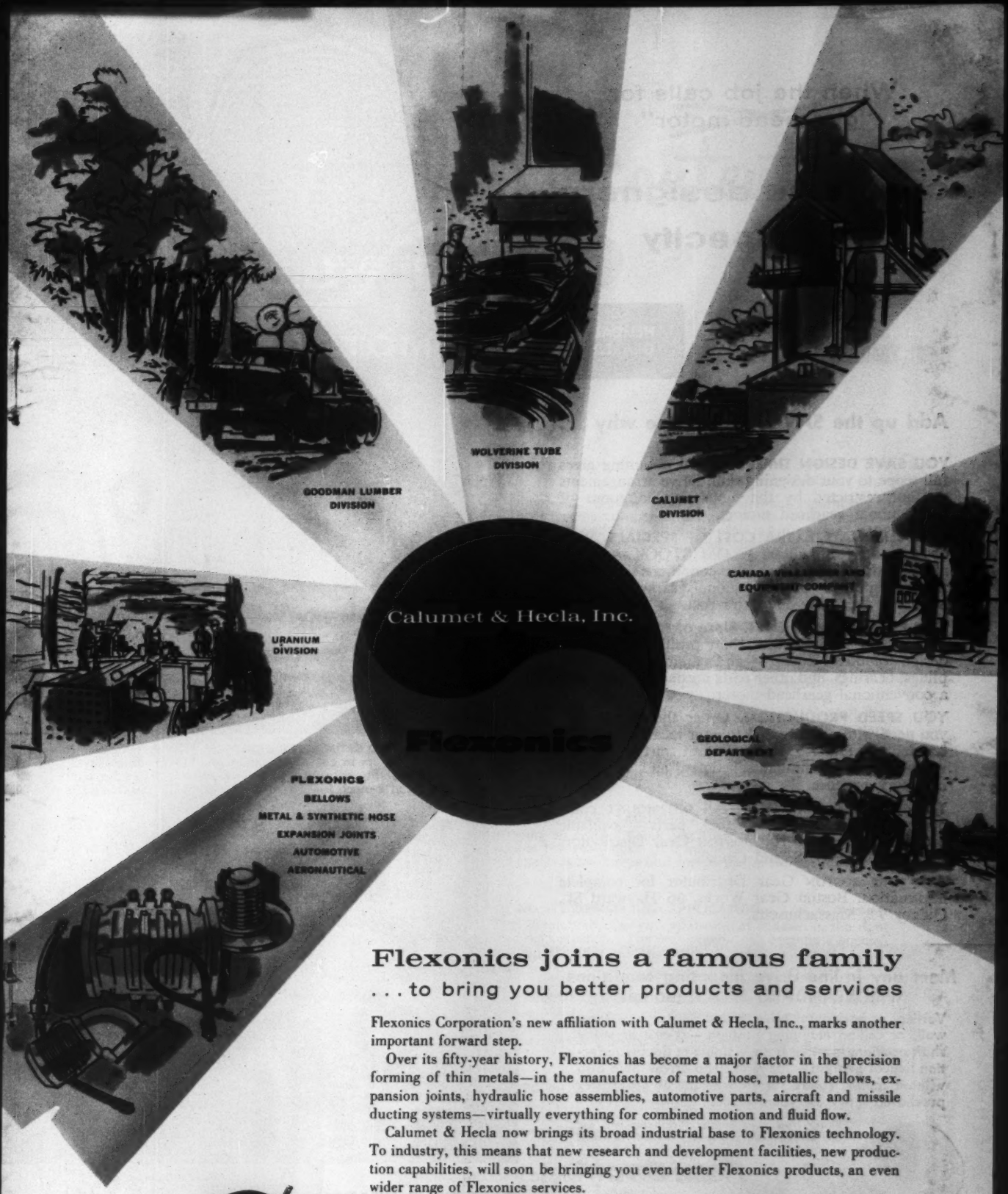
BOILER DIVISION



Flexonics joins a famous family

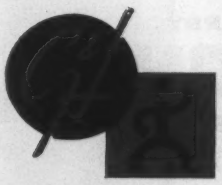
. . . to bring you better products and services

Flexonics Corporation's new affiliation with Calumet & Hecla, Inc., marks another important forward step.

Over its fifty-year history, Flexonics has become a major factor in the precision forming of thin metals—in the manufacture of metal hose, metallic bellows, expansion joints, hydraulic hose assemblies, automotive parts, aircraft and missile ducting systems—virtually everything for combined motion and fluid flow.

Calumet & Hecla now brings its broad industrial base to Flexonics technology. To industry, this means that new research and development facilities, new production capabilities, will soon be bringing you even better Flexonics products, an even wider range of Flexonics services.

The entire Flexonics organization is looking forward to serving you better . . . in more ways.



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MECHANICAL ENGINEERING

PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Contents

VOLUME 82 • NUMBER 2 • FEBRUARY, 1960

EDITORIAL DEPARTMENT

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THE COVER

Ready for shipment: One of the first fuel-element assemblies for Yankee Atomic Electric Company's plant at Rowe, Mass. Supplier: Westinghouse, Pittsburgh, Pa. Each assembly is 8 in. square and 8 ft long, with 304 stainless-steel tubes, each containing 150 pellets of slightly enriched uranium oxide. The 134,000-kw plant will have 76 of these units in its pressurized water reactor. Yankee Atomic is a Massachusetts electric company formed by 10 New England utilities to construct a commercial atomic plant.

THE ENGINEER IN INTERNATIONAL AFFAIRS.....**W. L. Cisler** 54

That rare individual, the true man-of-the-world, is our hope in a shrinking world. Does the American engineer qualify for membership in that broad-gage fraternity? A report from ASME's President.

PUMP STANDARDIZATION—A USER'S CONCEPT.....**R. G. Jobe** 57

Sometimes it pays to sweep away previous designs and start fresh with a new philosophy. Here, the results will be savings both in maintenance and installed cost in a large chemical plant.

AIRCRAFT SEATING—FORWARD FACING? OR REARWARD?.....**I. I. Pinkel** 60

So you're going to crash. Think you'll be safer riding backward, braced against the seat-back? You might be wrong. An engineer from NASA analyzes the forces and compares the two propositions.

THE MANIPULATOR: ITS DESIGN AND APPLICATION.....**J. C. Somers** 64

Pick up that 20-ton load: Carry it, rotate it, set it down in the right place, in the right position. The manipulator has become a specialized field calling for continual innovation and invention.

PROGRESS IN RAILWAY MECHANICAL ENGINEERING.....**D. R. Meier** 66

In locomotives: More power. In freight cars: More accessories, greater efficiency in loading and unloading. Passenger cars? Only France designed one for tourists, a self-propelled dome car.

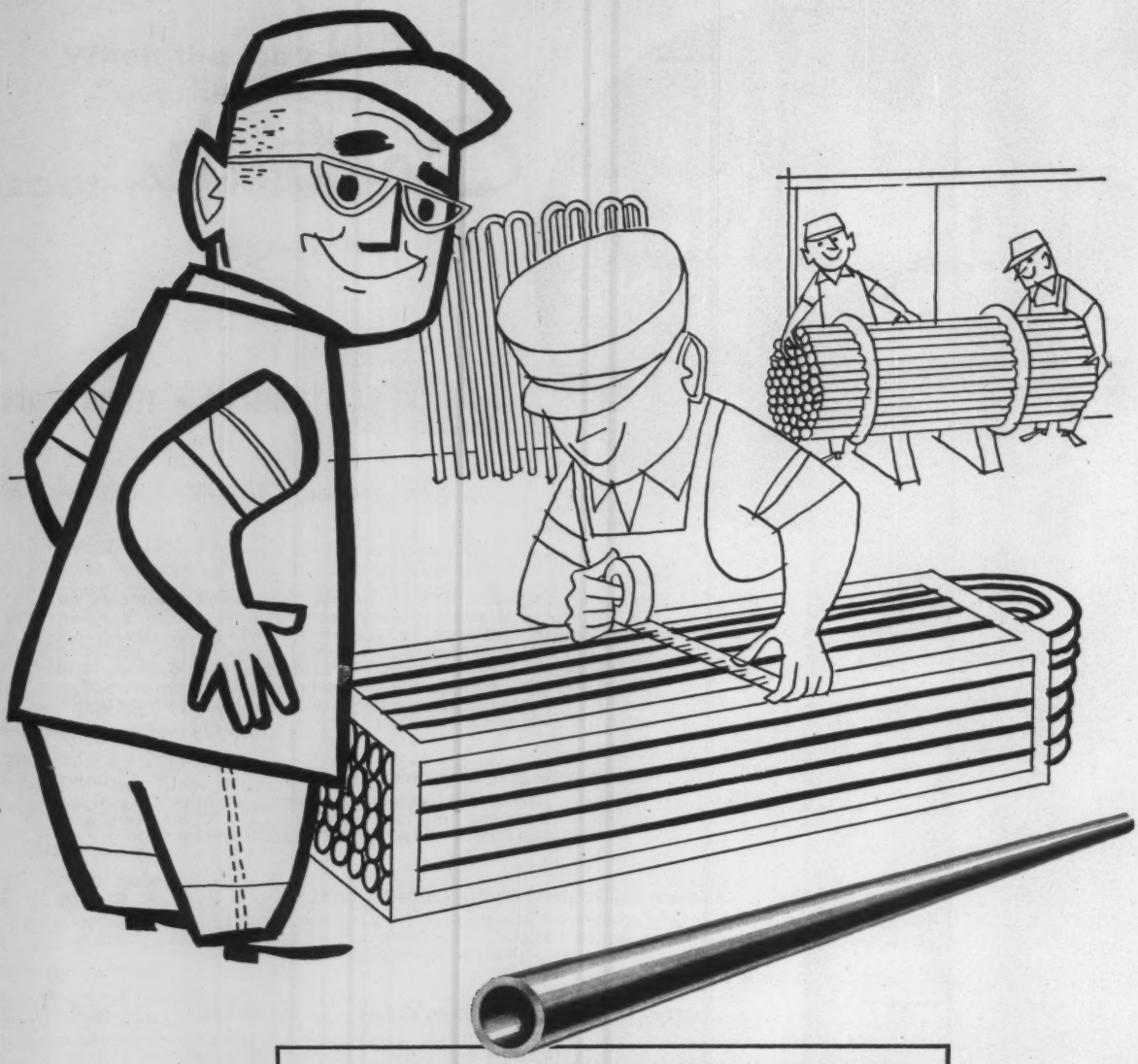
NEW TIRE-REINFORCING MATERIALS.....**C. A. Litzler** 76

Remember the first cord tires, around 1915? Well, the cords grew stronger—became rayon, then nylon. Now we have wire-reinforced tires. Developments come fast: The cord may even disappear.

TURBINE-BEARING DESIGN.....**P. C. Warner** 82

Conservative in design, the bearings of electric-utility turbines give excellent service. But study goes on, with thermocouples as monitors. Now, hydraulic alarm devices protect the turbines.

Contents continued on following page



How B&W JOB-MATCHED TUBES provide long service life in stainless steel

When you specify B&W Stainless Heat-Exchanger Tubes—either seamless or welded—you can count on:

- ... a complete range of stainless grades to meet any set of service conditions
- ... a wide variety of diameter and wall thickness combinations for all types of operating requirements
- ... fully annealed tubes for maximum resistance to corrosion

These are just a few of the reasons it pays to specify B&W Job-Matched Stainless Steel Heat-Exchanger Tubes. Call your local B&W District Sales Specialist, or write for Bulletin TB-329 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

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TUBULAR PRODUCTS DIVISION

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Contents (continued)

VOLUME 82 • NUMBER 2 • FEBRUARY, 1960

ADVERTISING DEPARTMENT

Departments

EDITORIAL 53

BRIEFING THE RECORD 86

The Next Decade 86
Automatic Inspection 86
Precision Contouring 87
Progress on Fusion Power 87
Continuous Heat-Treating 88
High-Temperature Laminates 88
"Pumped-Storage" Power 89
Plant Protection 89
Cross-Country Conveyer 90
Checking Coal Stoppages 90
"Dial 'D' for Democracy" 91
91 "Economatic" Transfer Machines
92 Gas-Lubricated Bearings
94 Electrolytic Machining
94 Earthquake-Proof Reactor
95 Frozen-Wall Excavation
96 Tidal Power Turbines
97 All-Plastic Pumps
97 Plasma-Accelerator Propulsion
98 Materials Briefs
99 Nuclear Progress and Outlook
99 Nuclear Briefs

PHOTO BRIEFS 100

Atom Watchers 100
Big Wheel 100
Remote-Control Manipulator 100
101 Plastic Jet-Engine Housing
101 Glass Heat Exchanger
101 Rotary Assembly Line
101 Levacar "Mach 1"

EUROPEAN SURVEY 102

Marine Diesel Engine 102
Internal-Helical-Gear Grinder 102
103 Terylene Ducting
103 New Reactor for O.E.E.C. Research

ASME TECHNICAL DIGEST 104

Rubber and Plastics 104
Power 105
Fuels 106
Machine Design 107
Hydraulics 108
Heat Transfer 109
Boiler Feedwater Studies 110
111 Air Pollution Control
112 Fluid Meters
112 Human Factors Engineering
113 Applied Mechanics
115 ASME Transactions for January, 1960

COMMENTS ON PAPERS 116

BOOKS RECEIVED IN LIBRARY 122

THE ROUNDUP 124

1960 Nuclear Congress Program Announced 124
Institute of Defense Analyses Meets With EJC 125
I.Mech.E. Meetings 125
AAAS Section M Conference Report 126
126 People
127 Coming Meetings
128 United Engineering Center
130 Fourth Engineering Technician Survey
130 Industrial Films
130 Meetings of Other Societies

THE ASME NEWS 131

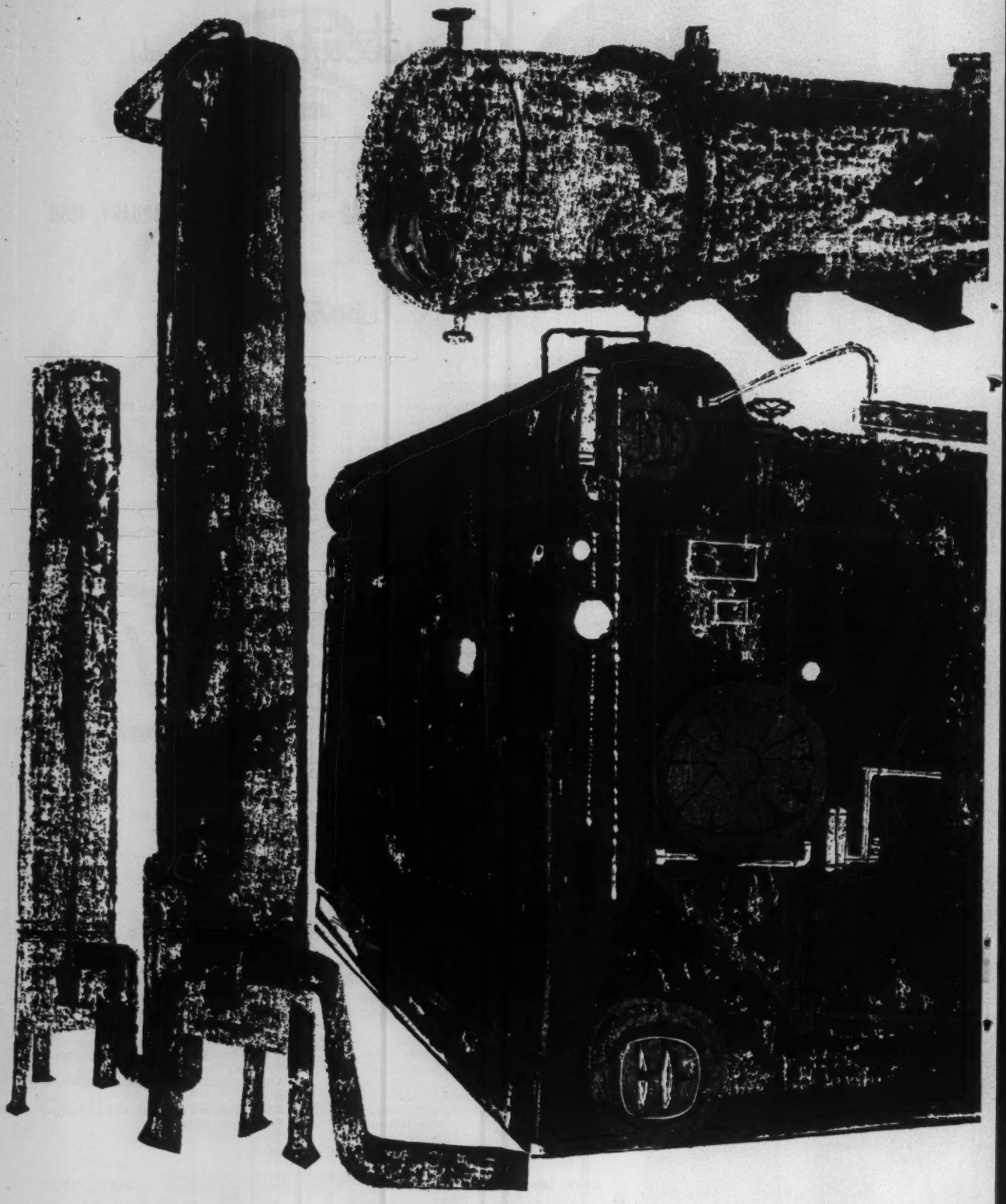
Design Engineering Show 131
Lubrication Symposium 132
Research 132
Textile Engineering Conference 132
ASME San Francisco Section Conference 133
Junior Forum 134
ASME Coming Events 135
136 Solar Energy Applications Discussed by Americans and Japanese
136 ASME Codes and Standards Workshop
138 ASME Elects Ten to Grade of Fellow
140 Personnel Service
143 Candidates
143 Obituaries

KEEP INFORMED 147

202 ..... CONSULTANTS

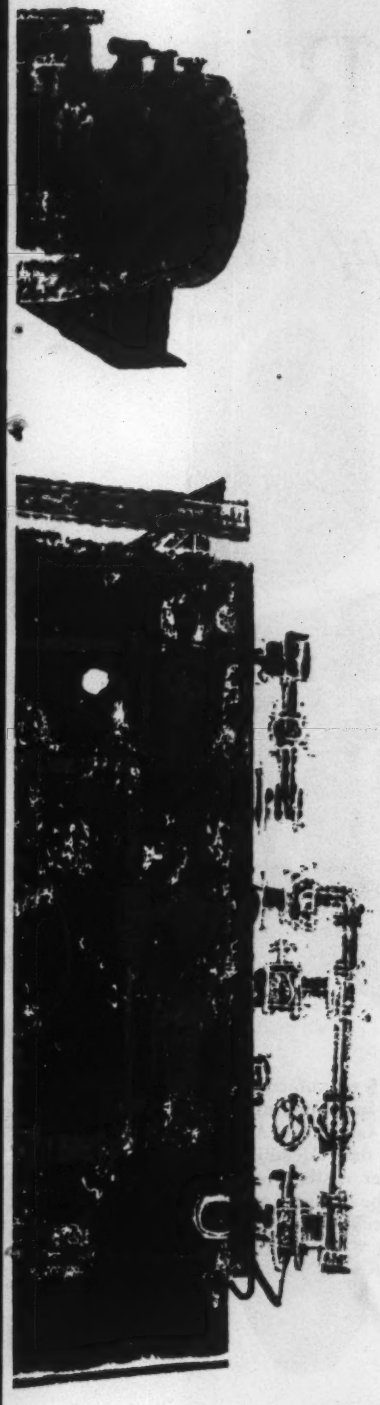
CLASSIFIED ADS 193

204 ..... ADVERTISING INDEX



POWER PLANT PRODUCTS HEAT ENGINEERED BY FOSTER WHEELER:

Central Station and Industrial Steam Generators • Steam Condensers and Pumps • Pulverized Fuel Systems • Feedwater Heaters • Packaged Steam Generators • Cooling Towers • Nuclear Components



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At Foster Wheeler *extra thoroughness* is standard procedure. FW engineers are more than just designers and builders of equipment. They are also men with experience in the overall application, operation and servicing of power plant equipment. In knowing a little more about the whole plant, they are better able to produce efficient, rugged, easy-to-operate equipment.

This *extra thoroughness* also refers to the conscientious work of FW shop men and technicians who are familiar with equipment end-use. They never forget that operating conditions are often more severe than those created in standard shop tests.

And this *extra thoroughness* is further demonstrated in the training and supervision of the people responsible for product design and fabrication.

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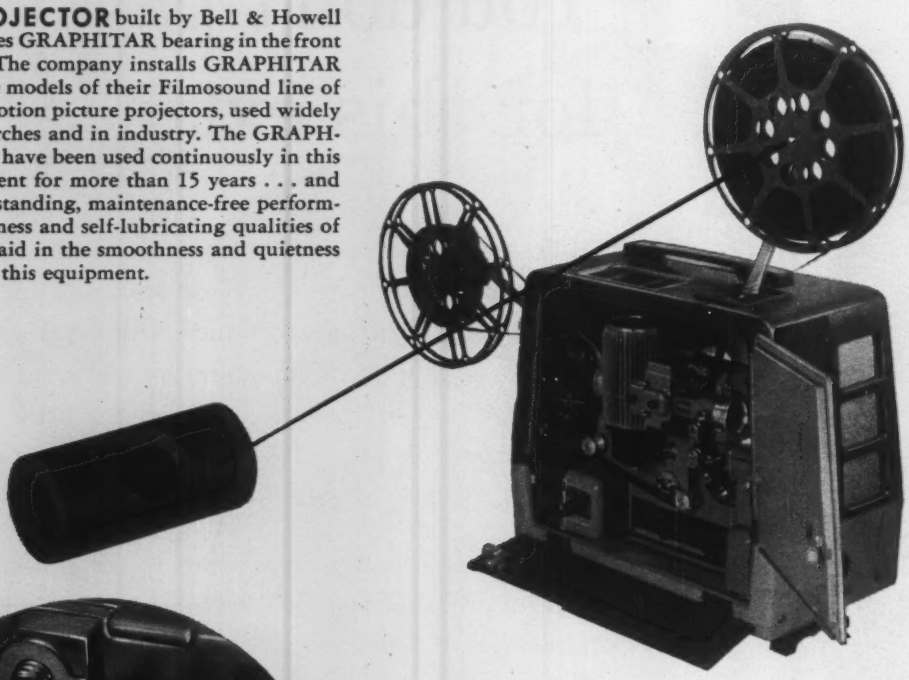
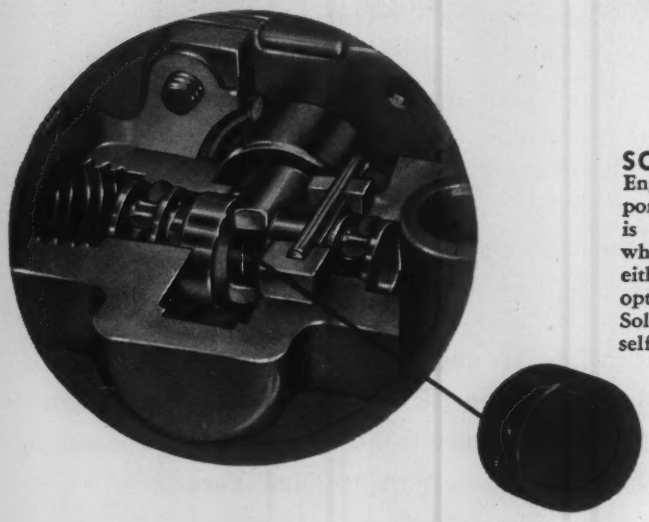
this is GRAPHITAR®

(CARBON-GRAPHITE)

successful in a wide variety of applications

MOVIE PROJECTOR built by Bell & Howell Company utilizes GRAPHITAR bearing in the front reel assembly. The company installs GRAPHITAR bearings in five models of their Filmosound line of 16mm sound motion picture projectors, used widely in schools, churches and in industry. The GRAPHITAR bearings have been used continuously in this line of equipment for more than 15 years . . . and have given outstanding, maintenance-free performance. The hardness and self-lubricating qualities of GRAPHITAR aid in the smoothness and quietness of operation in this equipment.

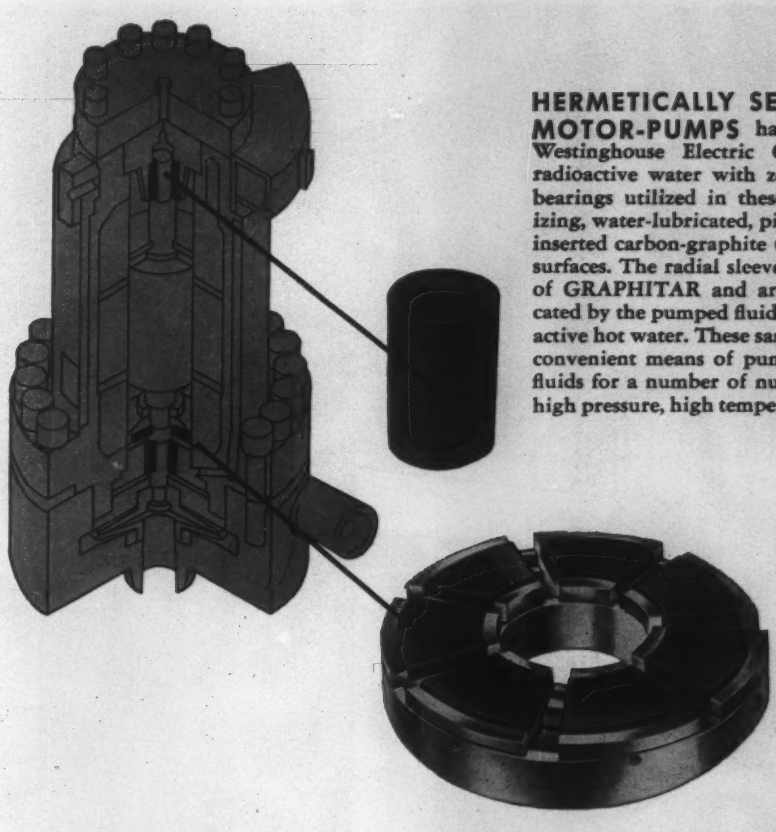




SOLENOID VALVES manufactured by Valcor Engineering Co. for use in guided missiles incorporate a floating seal of GRAPHITAR. This seal is a precise, optically flat GRAPHITAR disc which floats in the plunger. A slight pressure, from either direction, moves the disc against an equally optically flat, stainless steel seat, sealing perfectly. Solenoid valve improves with use due to unique self-lapping action of GRAPHITAR.

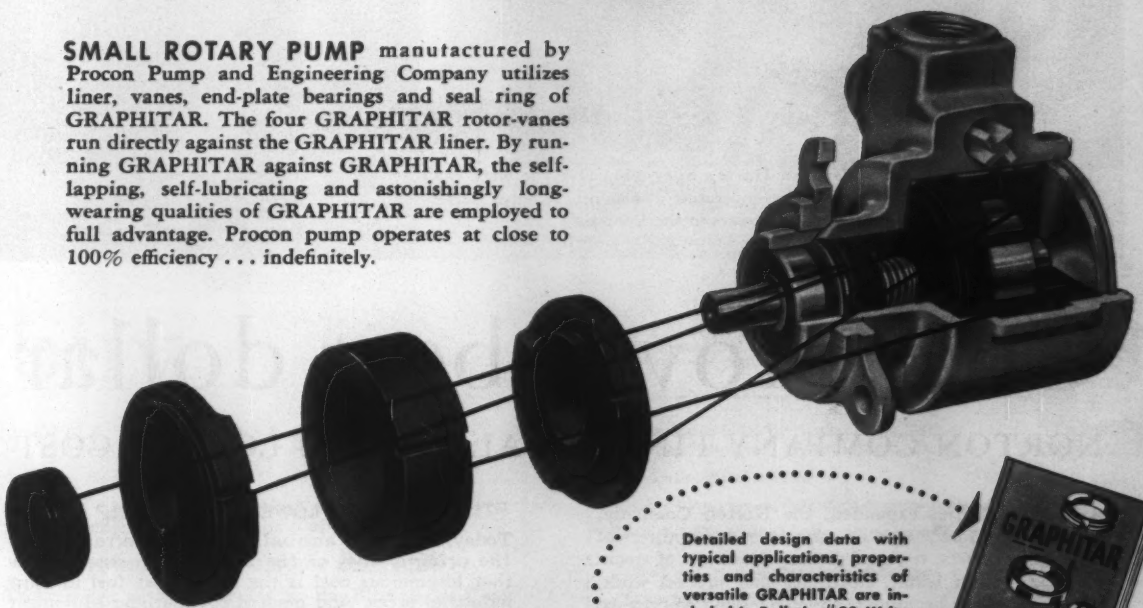
THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



HERMETICALLY SEALED MOTOR-PUMPS have been developed by Westinghouse Electric Corporation to handle radioactive water with zero leakage. The thrust bearings utilized in these pumps are self-equalizing, water-lubricated, pivoted-pad bearings with inserted carbon-graphite (GRAPHITAR) bearing surfaces. The radial sleeve bearings are also made of GRAPHITAR and are designed to be lubricated by the pumped fluid only, in this case, radioactive hot water. These same pumps have proven a convenient means of pumping high temperature fluids for a number of nuclear reactors and other high pressure, high temperature fluid applications.

SMALL ROTARY PUMP manufactured by Procon Pump and Engineering Company utilizes liner, vanes, end-plate bearings and seal ring of GRAPHITAR. The four GRAPHITAR rotor-vanes run directly against the GRAPHITAR liner. By running GRAPHITAR against GRAPHITAR, the self-lapping, self-lubricating and astonishingly long-wearing qualities of GRAPHITAR are employed to full advantage. Procon pump operates at close to 100% efficiency . . . indefinitely.



Detailed design data with typical applications, properties and characteristics of versatile GRAPHITAR are included in Bulletin #20. Write for your free copy.

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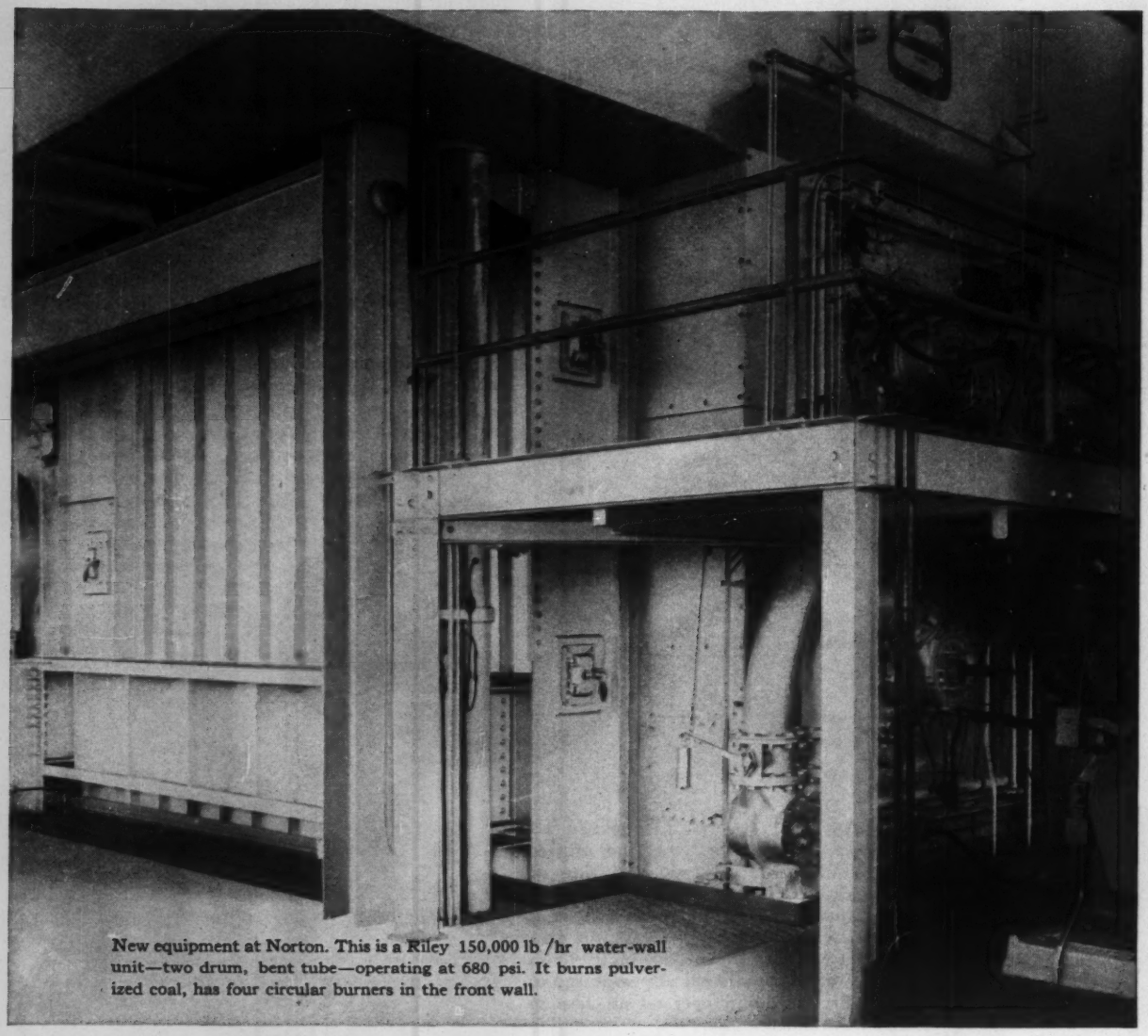
GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN



New equipment at Norton. This is a Riley 150,000 lb /hr water-wall unit—two drum, bent tube—operating at 680 psi. It burns pulverized coal, has four circular burners in the front wall.

Coal proves best dollar

NORTON COMPANY FINDS COAL STILL IS LOWEST COST

As plant facilities expanded, the Norton Company, Worcester, Mass., world's largest manufacturer of abrasive products, required greater quantities of steam for heating, hot water, electricity and process work. This expansion prompted an engineering survey to determine future power needs. As a result, Norton staff engineers—working with K. R. Warrington, Consulting Engineers—decided to install additional steam generating equipment. Coal had been used previously because it was the most economical of the fuels in that area when the original plant was installed. Coal *continues* as the fuel of the new plant for the same reason. Norton management is sold on the fact that, dollar for dollar, coal is the best fuel buy.

COAL IS LOWEST COST FUEL

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% more steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

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If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel

In the center, ash hoppers—part of United Conveyor steam vacuum ash handling system—lead to underground conveyor which moves ashes to outside storage silo. At right: coal pulverizers.

From track hopper, 100 ton/hr boom conveyor (right) carries coal to storage area. Bucket conveyor (center) lifts it to belt conveyor at top of plant. Coal handling system by William T. Donovan Co. and Jeffrey Manufacturing Co.

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FUEL IN ITS AREA

costs and equipment—can effect great savings for you with the efficiency and economy of coal.

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To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

BITUMINOUS COAL INSTITUTE

Department ME-02, Southern Building, Washington 5, D. C.

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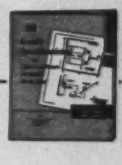
Guide Specifications, with complete equipment criteria and boiler room plans:



Bituminous Coal Institute, Dept. ME-02
Southern Building, Washington 5, D. C.

Gentlemen: Please send me:

- ☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker).
- ☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker).
- ☐ GS-3 (automatic package boiler for heating and process plants).
- ☐ Case histories on larger plants.

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new nuclear plants choose

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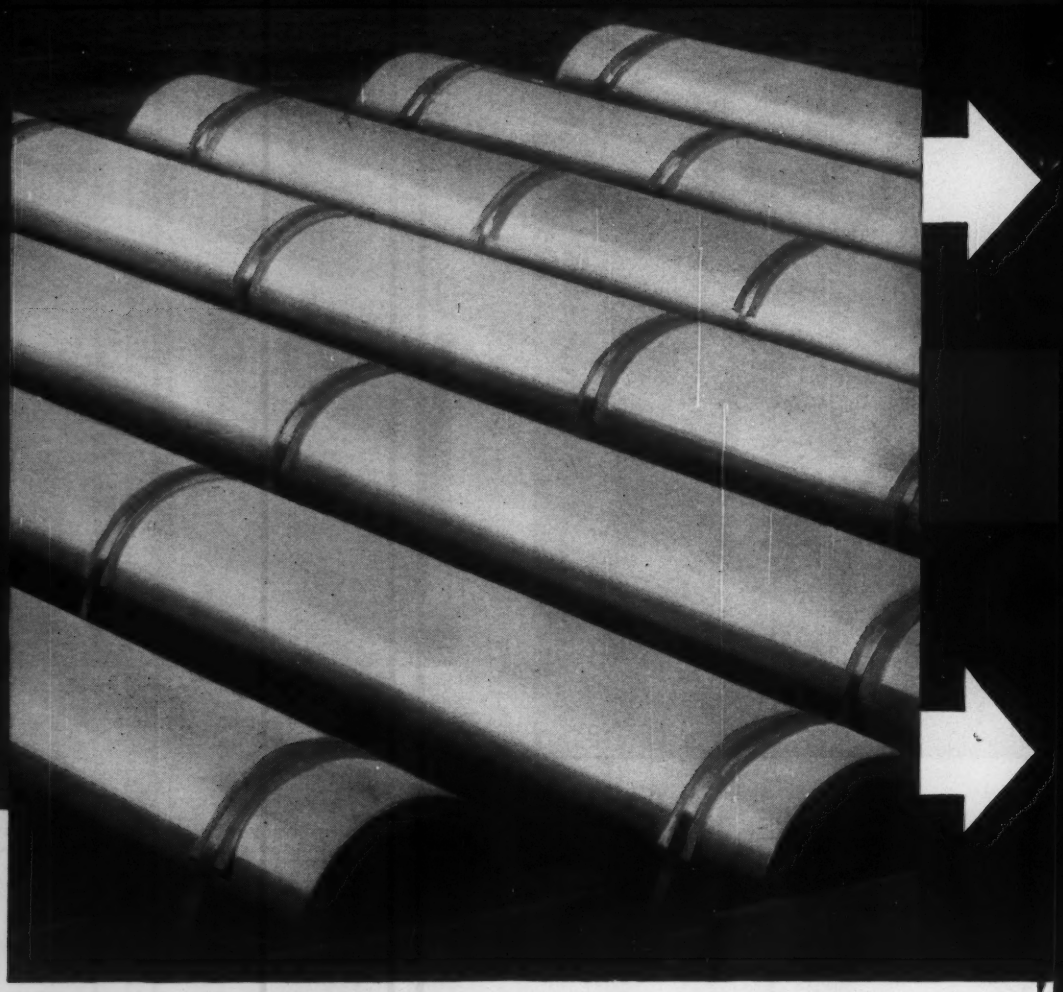


Centrifugal stainless steel castings cycled for shipment by U.S. Pipe

The Government's new SPERT III nuclear plant at the National Reactor Station near Idaho Falls, Idaho, operating since December, 1958 to study nuclear reactor safety, uses U.S. Pipe's centrifugally cast stainless steel pipe for its coolant system.

SPERT III is classified as a high pressure, high temperature, light water moderated and cooled reactor. Its versatility permits transient tests under various initial conditions of pressure, temperature, and coolant flow. For example, pressures ranging from atmospheric to 2,500 psi and water temperatures from 68° to 668° F.

Another new nuclear power plant, engineered and constructed by Stone & Webster for Yankee Atomic Electric Company, is using centrifugally cast stainless steel heat exchanger shells made by U.S. Pipe and fabricated by the Southwestern Engineering Company in Los Angeles, Calif.

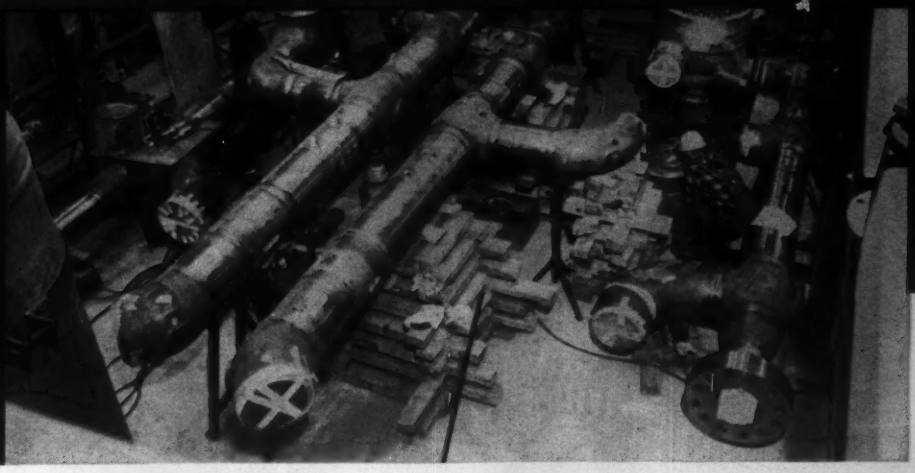
Stainless steel, centrifugally cast, made to rigid specifications, may be the answer to your piping or heat exchanger problem. For more information, write or call:

centrifugally cast stainless

REQUIREMENTS OF [illegible]
AND COOLANT SYSTEMS

Shop-fabricated heat exchanger shells of centrifugally cast stainless steel ready for shipment to the Yankee Atomic Electric plant at Rowe, Mass.

Subassemblies of primary coolant piping of centrifugally cast stainless steel being installed at SPERT III.



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To help meet the demands of tight production schedules, YODER Slitters reduce mill-width stock quickly and economically to desired widths. If your needs are as low as 100 tons per month, time and manpower savings alone will offset the cost of your YODER Slitter in a matter of months, while reducing basic inventories. Compactly designed, standard YODER Slitters are built to handle standard coil widths...completely engineered lines for special requirements.

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YODER also makes a complete line of Cold Roll-Forming equipment and Pipe and Tube Mills. To profit from YODER'S years of engineering and service experience, contact your local YODER representative or send for the YODER Slitter Manual.

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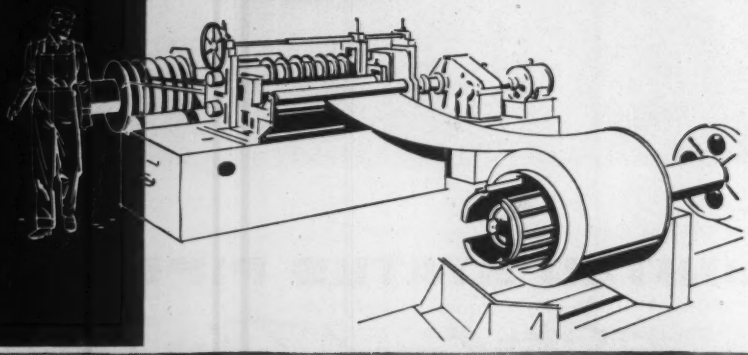


ENGINEERING **YODER** MANUFACTURING

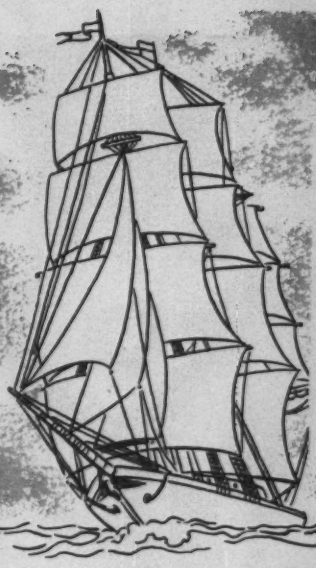
ROTARY SLITTING LINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)

COLD ROLL FORMING MACHINES

Why Rust-Oleum is different—

and what this difference, backed by 35 years of industry proof, means to you!



A Sea Captain developed it . . . Industry proved it!

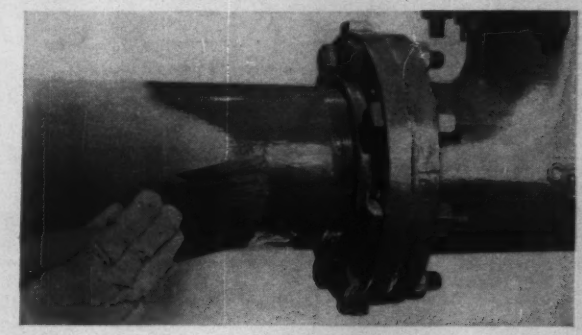
The original Rust-Oleum formula was developed nearly fifty years ago by Sea Captain Robert Fergusson, who became intrigued with the rust-stopping qualities of fish oil early in his career. Creating a *special treatment* for the fish oil, he used the *specially-processed fish oil* as the vehicle in combination with fine rust-inhibiting pigments. The result? A coating that actually *stopped rust* when applied directly over sound rusted surfaces, after scraping and wirebrushing to remove rust scale and loose rust. Possible, because the *specially-processed* fish oil penetrated the rust to bare metal. This was the birth of Rust-Oleum's *exclusive* 769 Damp-Proof Red Primer.

PROVED THROUGHOUT INDUSTRY FOR OVER 35 YEARS

Today, Rust-Oleum in its many systems and colors, has been proved throughout industry for over thirty-five years. This proof by leading industrial users is your assurance of savings in time, money, and metal. Economies made possible by the fact that Rust-Oleum 769 Damp-Proof Red Primer goes right over the sound rusted metal—usually eliminating costly surface preparations. And Rust-Oleum, in its various systems, resists rain, sun, fumes, heat, weathering, chemicals, etc., for lasting beauty over the years.

RUST-OLEUM NEW COLOR HORIZONS SYSTEM

The Rust-Oleum New Color Horizons System introduces a new coating concept to industry. It combines four important factors: (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, pipes, tanks, structural steel, fences, etc. Write for complete information or contact your nearby Rust-Oleum Industrial Distributor. He maintains complete stocks for prompt service.



RUST-OLEUM®

There are imitations, but only *one* Rust-Oleum
It is distinctive as your own fingerprint

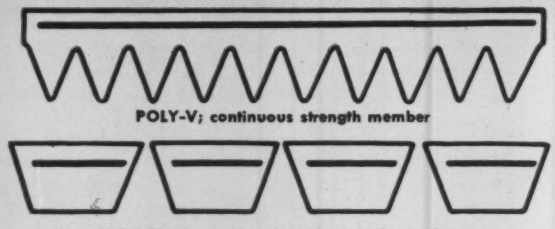
STOPS RUST!®

ATTACH TO YOUR LETTERHEAD

Rust-Oleum Corporation
2525 Oakton St., Evanston, Illinois

Please send me the following at no cost or obligation:

- ☐ New Color Horizons Systems Catalog featuring 110 actual color standards and 69 photo applications.
- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer to be applied over sound rusted surface.
- ☐ Results of radioactive tracing study on Rust-Oleum fish oil penetration.



"MORE USE PER DOLLAR"

Poly-V Belt is a single unit with even, uniform pull. Uninterrupted strength member gives much higher hp capacity per inch of drive width. No belt drive delivers as much power in the same space as Poly-V!

THIS R/M POLY-V® DRIVE OUTLASTED V-BELTS 8-1!

V-belts were replaced every six months on this gas pump drive in a southern chemical plant—until the company converted to R/M's patented Poly-V Drive. The single Poly-V Belt pictured above has been in operation for over 4 years on a barium process operation. Four years for the R/M Poly-V Drive versus 6 months for an ordinary V-belt drive! The savings and advantages to production are obvious.

R/M Poly-V Drive solves difficult drive problems wherever heavy duty power transmission is required. Single unit design permits *narrower* Poly-V sheaves to deliver *equal* power in a much smaller space or much *more* power in the same space as a V-belt drive! The drive runs smoother because there's no sinking of belt in sheave grooves. Belt speed ratios remain constant from *no* load to *full* load for uniform power delivery—with less wear on belts and sheaves. V-belt "length matching" problems are completely eliminated . . . and just two belt cross sections meet every heavy duty requirement. Let an R/M Distributor show you other advantages of converting to R/M Poly-V Drive. Write for Bulletin M141.

- **More Power—Less Space**
- **Eliminates "Matching" Problems**
- **Maintains Groove Shape**
- **Assures Constant Speed Ratios**
- **Longer Belt and Sheave Life**
- **Cooler, Smoother Running**

RM1010

When You Change Drives, Convert to Poly-V and Be Sure!

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM

ENGINEERED-RUBBER PRODUCTS ... MORE USE PER DOLLAR

New from American-Standard
Industrial Division

Power-Lift† for Power Plants

Power-Lift is a timely new concept of coordinated products and services from American-Standard Industrial Division. Its purpose is to help you raise overall efficiency in your plant by offering *products* that are proved in the field and designed, engineered, and manufactured to a uniform standard of quality and performance . . . with *service* by product specialists in every principal city.

To see how Power-Lift services can benefit you . . .

← LIFT THE FLAP

† Service-mark of American-Standard

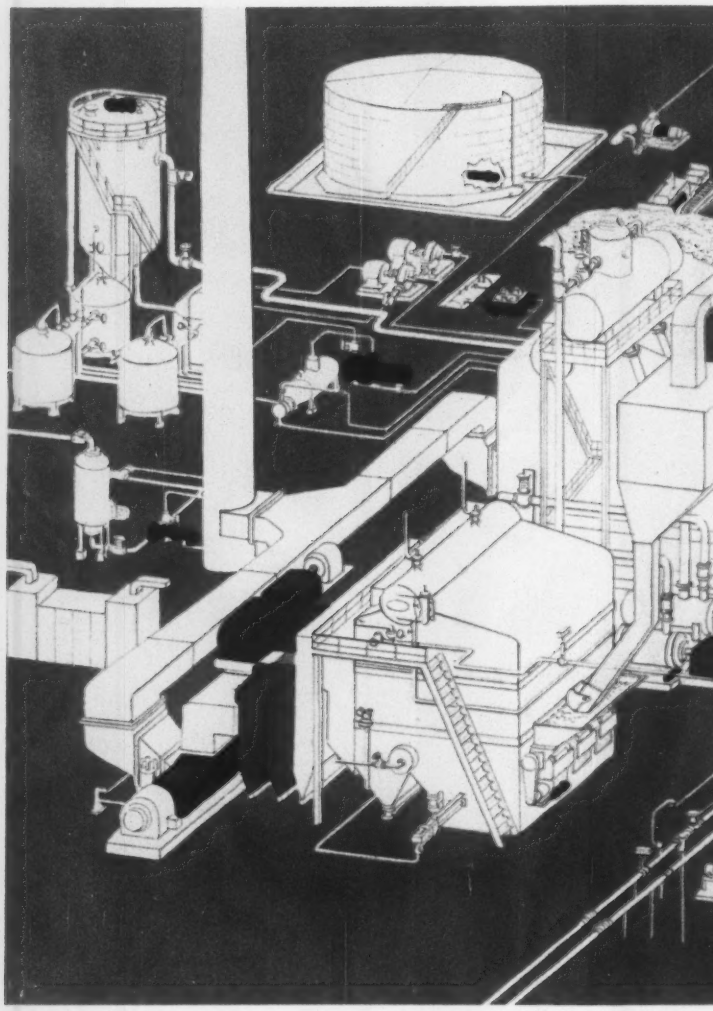
American-Standard Industrial Division **POWER-LIFT IN ACTION**

1959

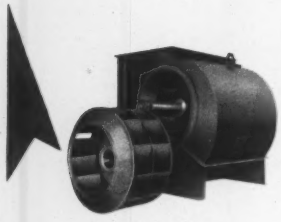
Early in 1959 three American-Standard divisions—American Blower, Ross Heat Exchanger, and Kewanee Boiler—were combined into a single organization under a new name: American-Standard Industrial Division. The year 1959 was spent fruitfully—consolidating product lines, accelerating new product development, gearing up to meet the stepped-up requirements of the fast-paced, highly specialized power industry.

1960

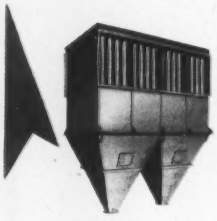
Today, we're confident that you'll find new benefits in specifying products from American-Standard Industrial Division . . . products that now encompass the major fields of heat transfer, mechanical draft, boiler feed pump and fan control, fly ash and dust control, heating, ventilating, and air conditioning. The illustration at right shows where many of these products may be applied in a modern steam plant. Each is designed, engineered, and manufactured to help you produce power efficiently and economically. Each is backed by an honestly won reputation for reliability on the job.



Here's where some of America



Mechanical Draft Fans



Dust and Fly Ash Collectors

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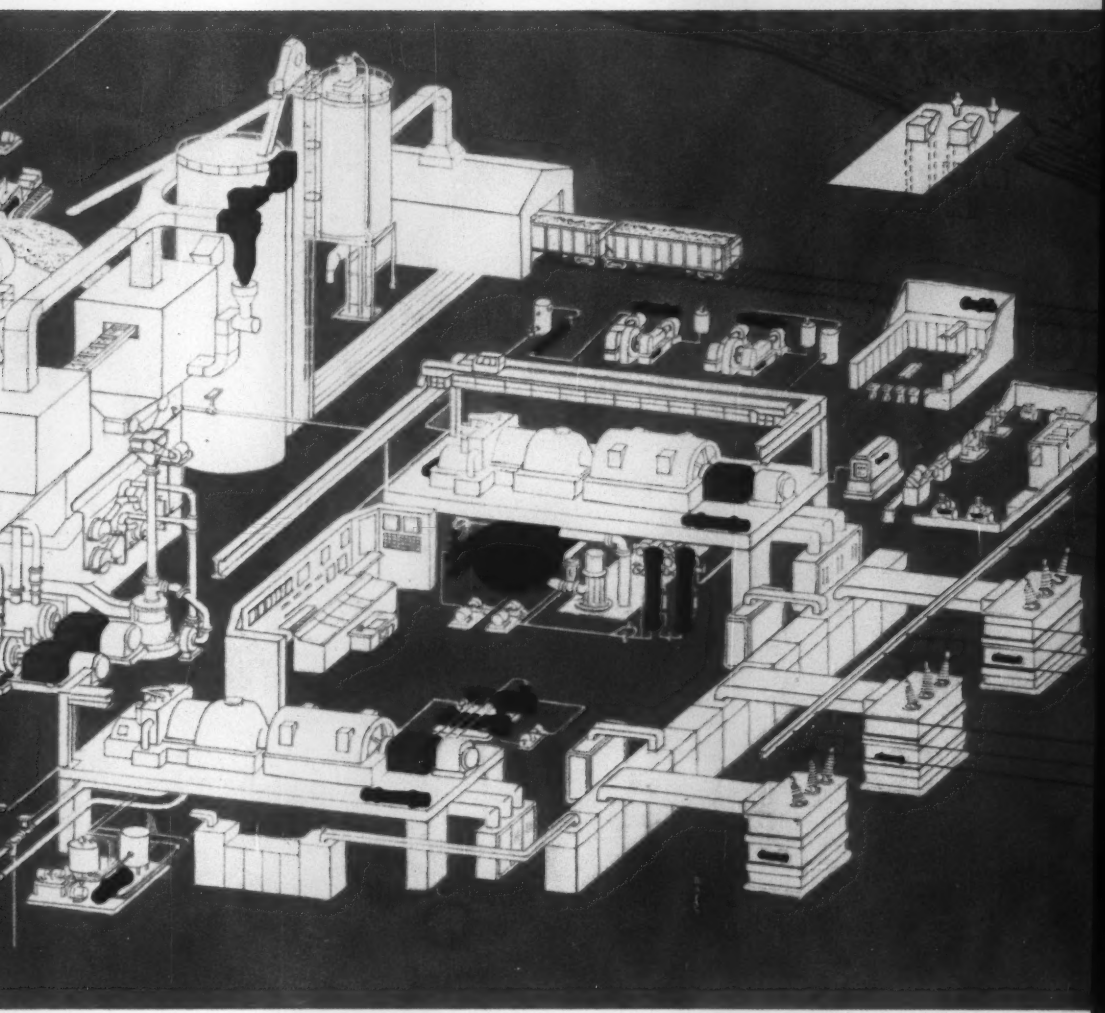
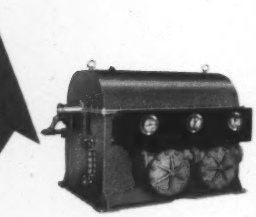
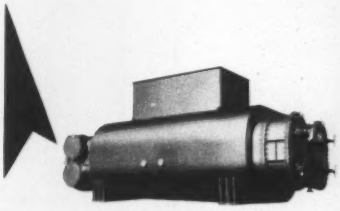


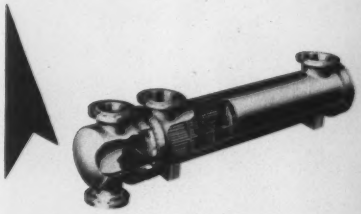
erican-Standard Industrial Division products serve in a modern power plant.



Gyrol® Fluid Drives for fan and feed pump control



Surface Condensers and Feedwater Heaters



Heat Exchangers and After Coolers

As Near as Your Phone

American-Standard Industrial Division Power-Lift Products and Services

Talk over your requirements with an American-Standard* Industrial Division product specialist. You'll find him well prepared and experienced—frequently able to base equipment recommendations upon precedents of proved success. And, in many instances, our comprehensive standardization paves the way to savings in time and cost. Offices in all principal cities. AMERICAN-STANDARD INDUSTRIAL DIVISION, DETROIT 32, MICHIGAN. IN CANADA: AMERICAN-STANDARD PRODUCTS (CANADA) LIMITED, TORONTO, ONTARIO. EXPORT DIVISION, AMERICAN-STANDARD, NEW YORK CITY.

SURFACE CONDENSERS

Designed to service the largest of today's and tomorrow's steam turbines. Low bundle entrance velocity; liberal steam transportation lanes; moisture impingement grids to extend tube life; expansion diaphragms; effective de-aeration and many other features created during 40 years of surface condenser development and research.

MECHANICAL DRAFT FANS

Complete range of sizes and types for forced draft, induced draft, gas recirculating, and primary air fan applications. Designed to meet rigid requirements of modern power plants where maximum pounds of steam are produced daily at peak efficiency. Airfoil, forward curved, backwardly inclined, radial, radial tip blades.

FEEDWATER HEATERS

Design incorporates unique new High Pressure closure. Maintenance is simplified with only four major parts. Exceptionally high safety factor built into all units—more than double ASME Code requirements. Temperature stresses from start-ups or load changes virtually non-existent.

HEAT EXCHANGERS

Designed and built with thoroughness and precision. Standard or specially engineered units for virtually all conditions and applications, including high pressure-high temperature exchangers, compressor inter- and after-coolers, fuel oil heaters, blow-down exchangers, and many others.

GYROL® FLUID DRIVE

Provides stepless adjustable speed control for fans and boiler feed pumps. Performance, power savings, and reliability proved in the field. Units for motor driven boiler feed pumps or for "on-the-shaft" duty on main turbine generator. Drives are available for fan and pump duties for all boiler sizes.

DUST AND FLY ASH COLLECTORS

Type "D" Dust Collector: mechanical "cyclone-type" collector. Series 342 Dust Collector: uses "cyclone" principle, with individual tubes which permit flexibility in design to fit plant layout. Series 361 Dust Collector: combines primary and secondary systems for high efficiency fly ash recovery.

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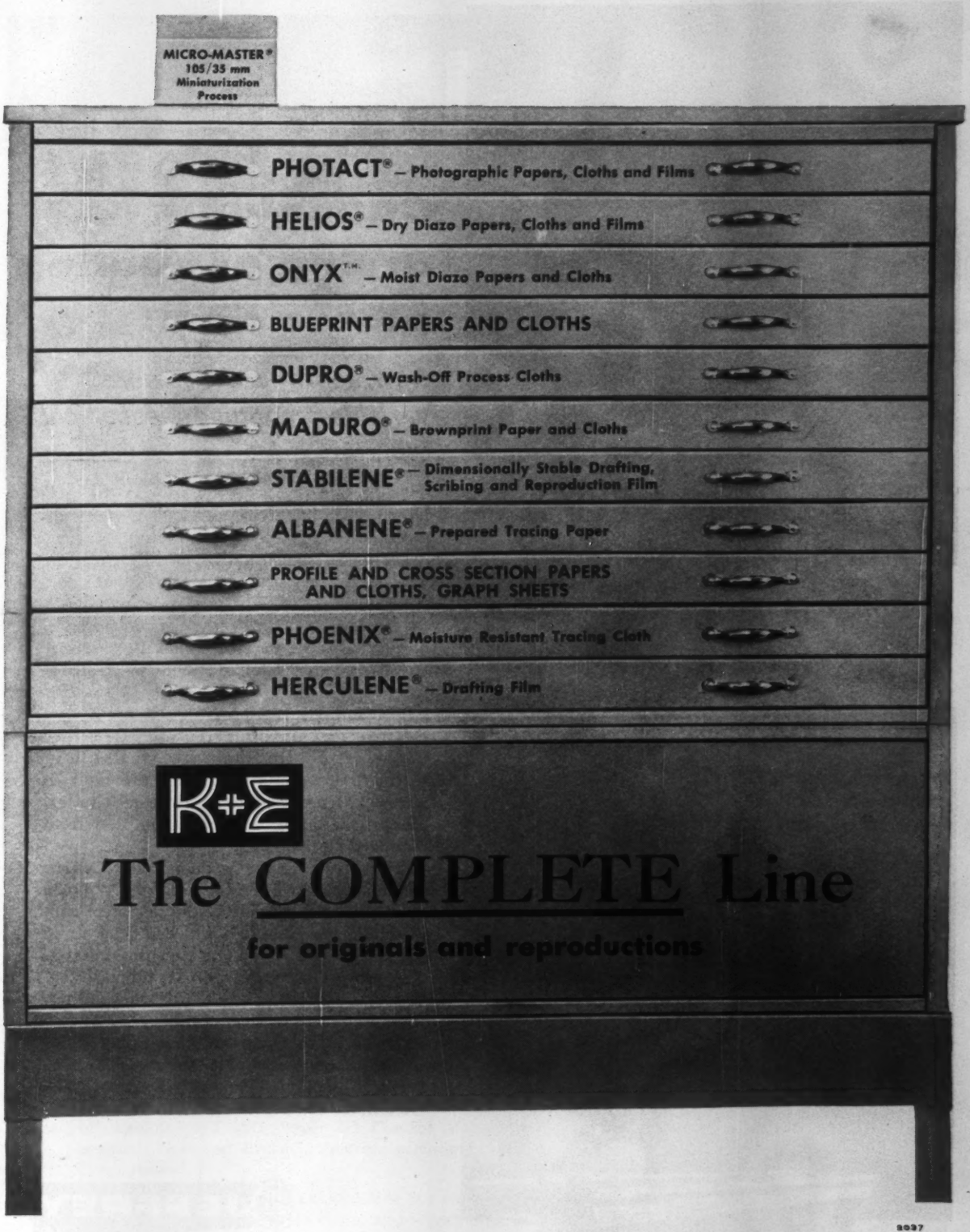
AMERICAN-Standard
INDUSTRIAL DIVISION

AMERICAN BLOWER PRODUCTS • ROSS PRODUCTS • KEWANEE PRODUCTS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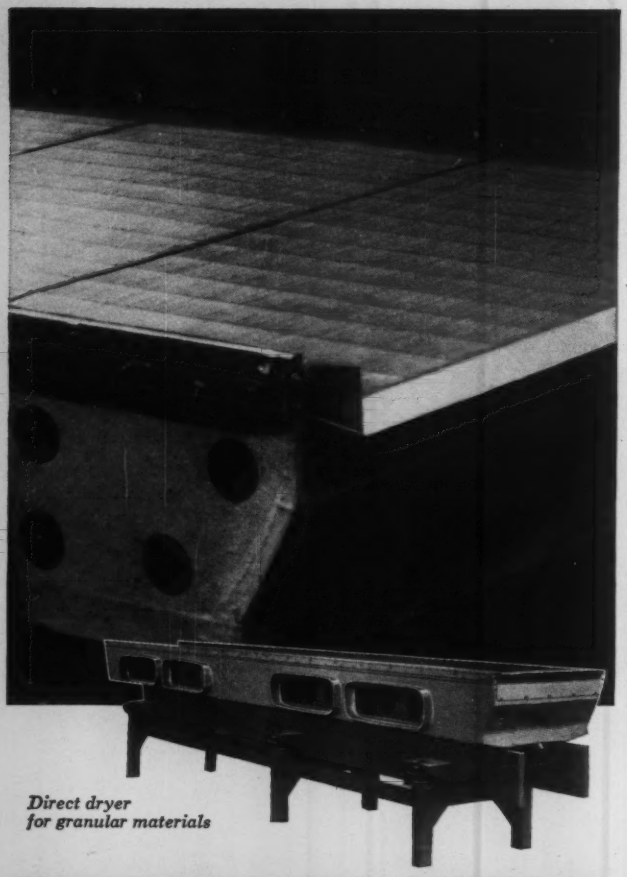
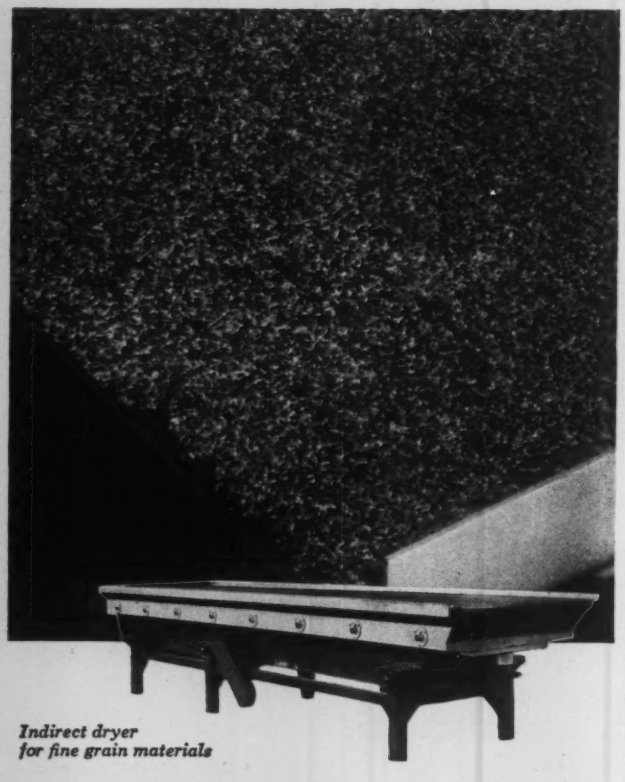


Direct dryer for granular materials



Indirect dryer for fine grain materials

Continuous drying or cooling at less cost!

New Jeffrey units feature variable-amplitude mechanical vibrating drive

Now proved in service, Jeffrey's new line of mechanical drive dryers is demonstrating lower maintenance and operating costs, in addition to savings in initial investment. Yet these dryers offer the same operating advantages as electric vibrating systems—variable amplitude drive permits adjusting speed of travel and depth of material as desired. Operation is fully automatic; heat transfer is fast and efficient.

These machines may be used for either drying or cooling and are available in direct or indirect types. They are built in standard lengths of 10 or 20 feet. A tailor-made installation can be assembled from standard components.

The direct dryer is designed to carry granular materials, in the range of ¼" down to about 60 mesh, on a stainless steel conveying surface through which drying air or gas is passed. The indirect type dryer carries very fine grain materials on a solid plate conveying surface, heated from below by low pressure steam or heated air.

Investigate this new cost cutter. For information write, The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT
...TRANSMISSION MACHINERY...
CONTRACT MANUFACTURING

"Life-Blood" of a Large Refinery!

BS&B Super 70 Diaphragm Control Valves with Clamp Ring—Float Ring Body Closure.

This natural gas metering station feeds 100 MMSCF of gas per day to a large Gulf Coast Refinery. If it were necessary to shut down the station for repairs, operation of the refinery would be seriously impaired.

That's why engineers who designed the station wanted to be absolutely sure the control valves would function properly day in and day out under all operating conditions.

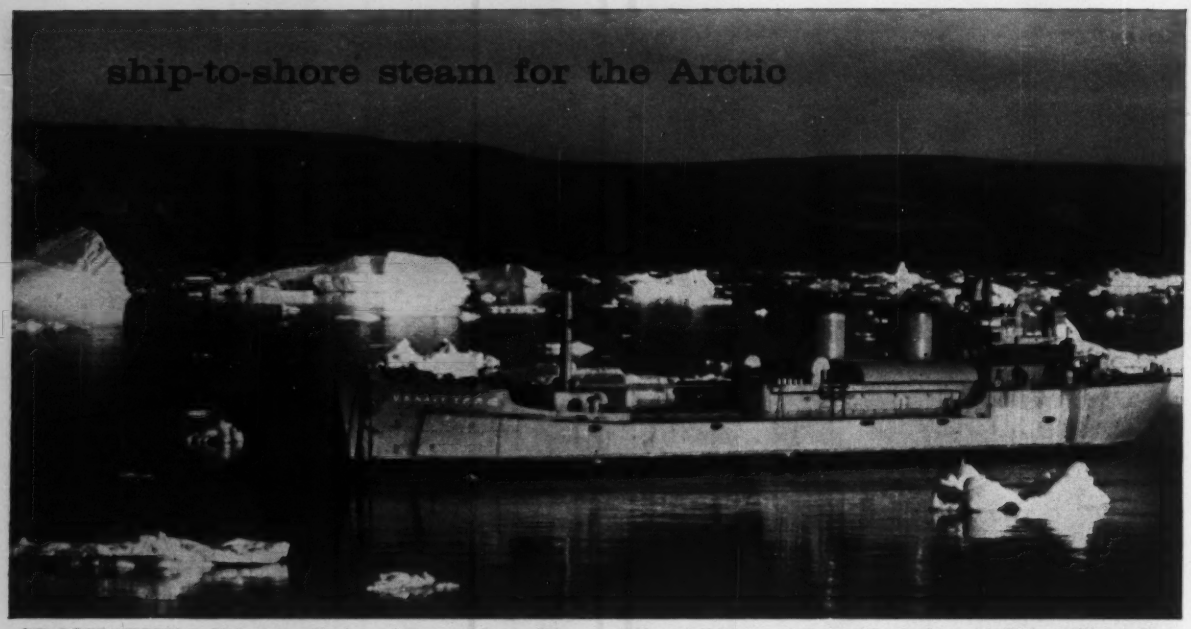
Because of their superior performance characteristics and rugged dependability . . . and because of BS&B's reputation for quality products and dependable service in the oil industry . . . BS&B Super 70 Control Valves were selected. Now "on stream", they are performing well in every respect.

BS&B Super 70 Valves are available in a complete range of sizes . . . with either clamp ring—float ring, or flanged—gasketed body closures. Specify them on your next job!

BLACK, SIVALLS & BRYSON, INC.

Controls Division,
Dept. 4-FQ2
7500 East 12th Street
Kansas City 26, Missouri

SUPER BS&B 70



CO-OPERATION — U.S. Army Engineers' Eastern Ocean District converted this Navy Floating Power Plant for the Arctic. Contractor — Bethlehem Steel Co.; consulting engineers — Metcalf and Eddy; and Reynolds, Smith and Hills. Military Sea Transportation Service towed it to northern Greenland where it will serve as part of the Ballistic Missile Early Warning System. (Photo credit, U.S. Navy)

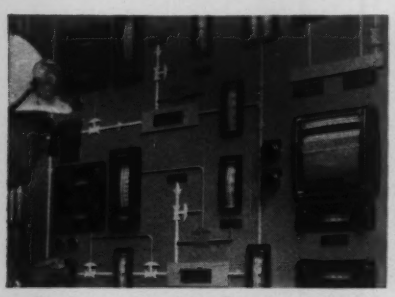
Foxboro controls "export" steam for unique Air Force floating power plant

A seagoing cargo vessel converted to a modern, shore-type steam-electric power plant. That's the YFP-10, designed for the Air Force — and floated to a site off northern Greenland where it will produce steam and power for the Ballistic Missile Early Warning System.

The YFP-10 can produce up to 135,000 pounds of export steam per hour. All steam temperature and pressure variables are under Foxboro control. Consotrol* control stations on the panel — Foxboro indicating pressure and temperature transmitters, and Foxboro valves on the line. Accurate, dependable, low-maintenance instruments — ideal for applications where top performance is critical.

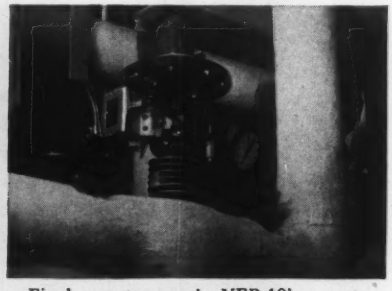
Afloat or ashore, nuclear or conventional — there's advanced Foxboro instrumentation for any power plant. Ask your nearby Foxboro Field Engineer for full details. Or write The Foxboro Company, 962 Neponset Ave., Foxboro, Mass.

*Reg. U.S. Pat. Off.



Foxboro Graphic Panel controls pressures and temperatures of steam "exported" from YFP-10. Instrument at right is Consotrol Recorder with Controller integrally mounted at rear. Complete control station pulls out like a drawer, making all adjustments and component parts easily accessible.

Foxboro M/44 Transmitters monitor both export steam temperatures and pressures aboard the YFP-10. Direct-connected, 4-inch indicators continue to give measurements even in event of instrument air failure.



Final operators on the YFP-10's export steam system are all Foxboro valves equipped with high-speed, super-response Vernier Valvactors*. Valvactors eliminate any problem of stem or plug friction, valve motor or transmission line lag.

*Reg. U.S. Pat. Off.

FOXBORO

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a STAR in Process SYSTEMS

UNI-FLEX/ ONE SOURCE for...

BELLOWS-TYPE EXPANSION JOINTS

U-Span — Convoluted — Double-Units.
Gimbaled and Tied.
Rectangular, Round or Square.
Custom-built Special Applications.
Pipe Size from 1/2" IPS to 36' Diameter.
Pressure range from Vacuum to 800 PSI in standard sizes; above on application.
Temperature Service from —320°F to 2000°F.
All Metals — Ferrous and Non-Ferrous.
To all Specifications: ASME — API — AWS — MIL 5923C.

COMPLETE CRYOGENIC SYSTEMS

Vacuum-Jacketed Vessels
Vacuum-Jacketed Transfer Lines — Minimum Heat Loss with Maximum Efficiency.

QUICK-OPENING COUPLINGS

Manual or Hydraulic.
Pressure or Vacuum Service.
Quick-Opening Doors and Manways — Steels or Alloys.

PLASTIC PRODUCTS

Structures for Today's Design Requirements.
Cryogenic Applications.
Corrosion Resistance Assemblies.
Fiberglass Reinforcement Products.
Vacuum Forming Sheets.
High Temperature — High Strength.

Over 100 Years of Specialization in the Precision Fabrication of Rugged-Process Systems.

UNI-FLEX—*one* technological source, with great flexibility in the manufacturing and design concepts of our specialized products. Our engineering force is always available to aid the designer, the project engineer and the buyer. *We welcome your inquiries.*

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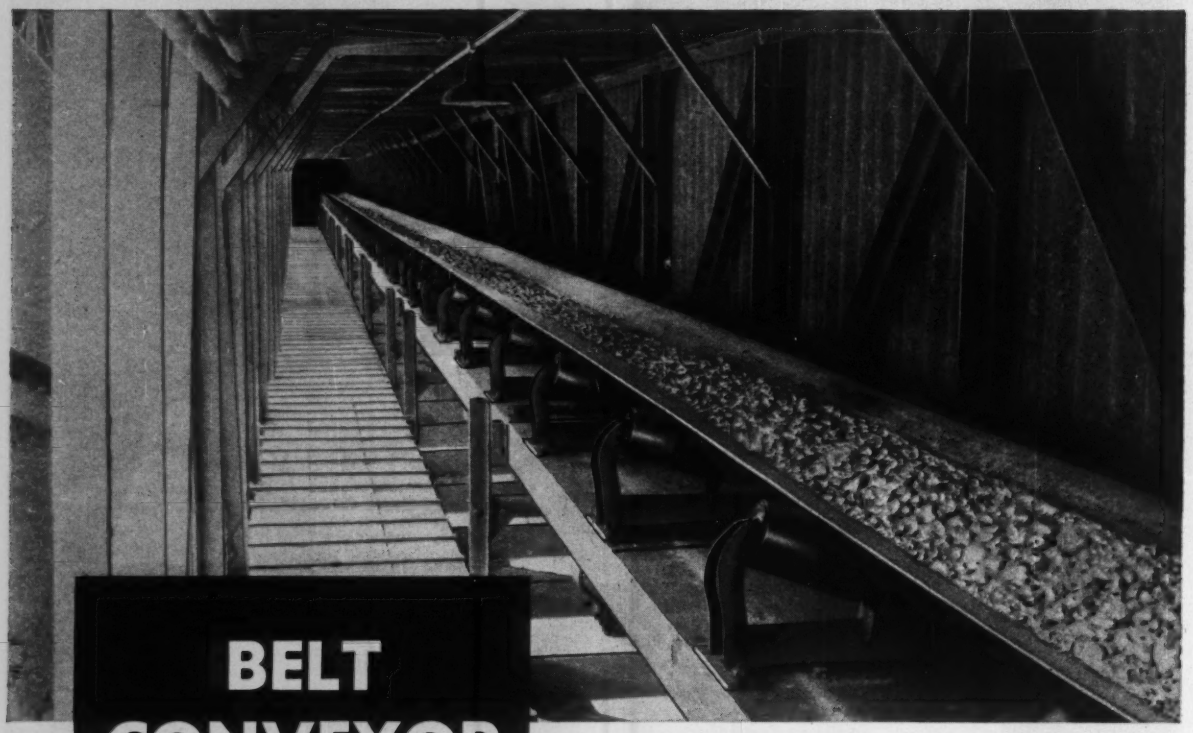
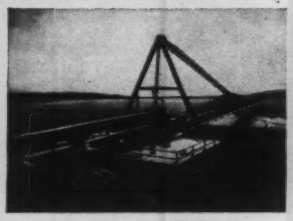


BELT CONVEYOR

handles greater tonnage at lower cost

Tons of crushed stone and aggregates are carried fast, efficiently and at a lower cost per ton on STEPHENS-ADAMSON Belt Conveyors. S-A quality engineered conveyor components increase materials handling efficiency while reducing equipment "down time" to a minimum. Long-lasting, low maintenance dependability is built into every S-A belt conveyor. Convey with S-A . . . the Equipment that's designed and built by the men who know conveying best . . . STEPHENS-ADAMSON.

S-A ENGINEERED PRODUCTS FOR BULK HANDLING



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BULLETIN 255

S-A TUNNEL GATES—
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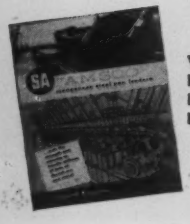

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S-A
ENGINEERED BULK HANDLING SYSTEMS
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SEALMASTER® BALL BEARING UNITS
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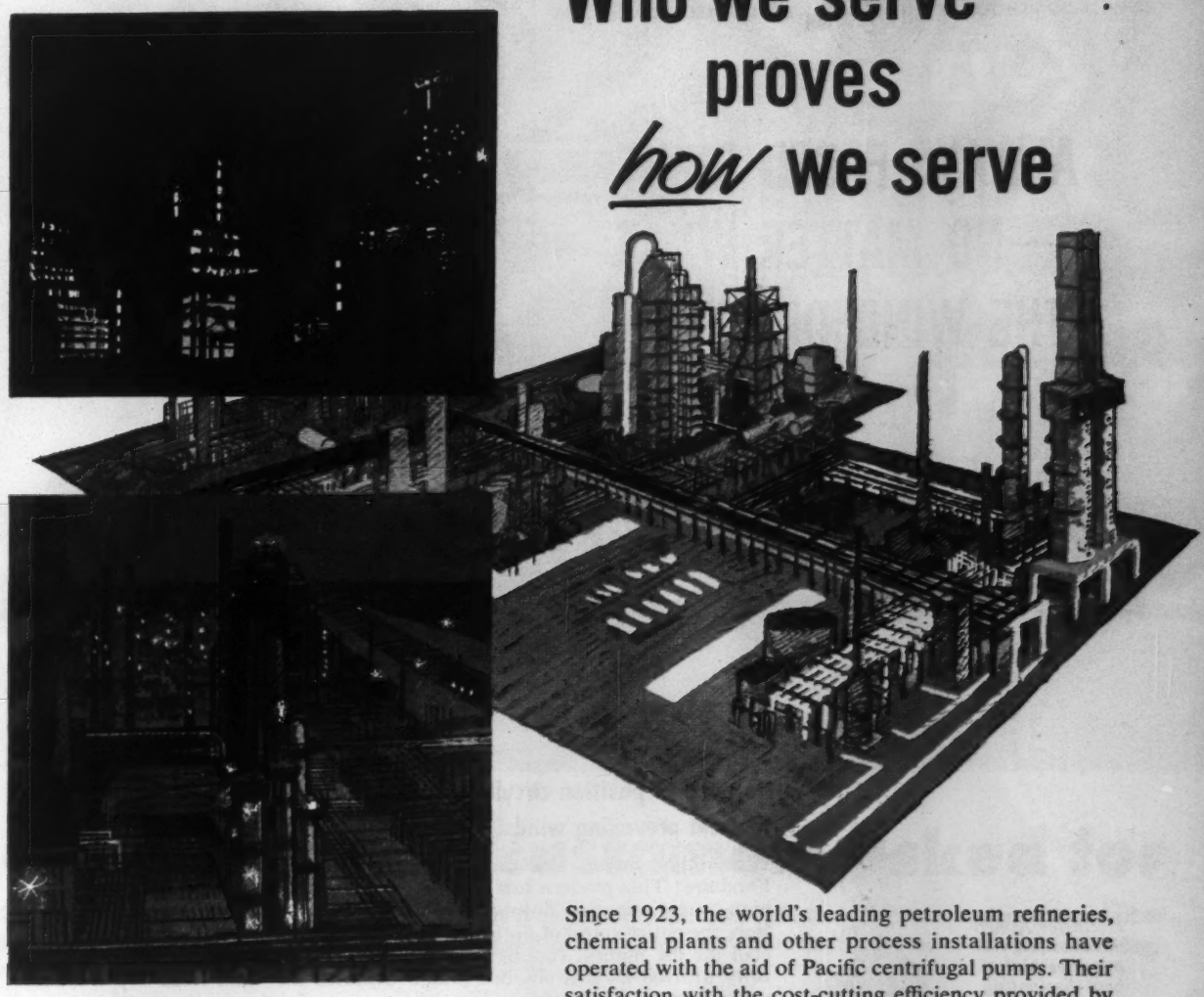
Who we serve proves *how* we serve



Since 1923, the world's leading petroleum refineries, chemical plants and other process installations have operated with the aid of Pacific centrifugal pumps. Their satisfaction with the cost-cutting efficiency provided by Pacific pumps is apparent in continuing repeat orders for plant expansion and new facilities.

There are several advantageous reasons for these re-orders; among them: (1) Pacific is a specialist in the development, design and manufacture of centrifugal pumps. (2) Pacific manufactures a wide variety of types and sizes to fill specific needs at the most beneficial cost/efficiency level. (3) Pacific provides technical advice and counsel to customers through an experienced sales engineering staff. (4) Pacific pumps may be financed in the leading currencies of the world.

There are other reasons why Pacific can serve you best. We would welcome an opportunity to tell you about them.

PACIFIC

Offices in all Principal Cities

PACIFIC PUMPS

Inc. . . A Division of Dresser Industries, Inc.

HUNTINGTON PARK, CALIFORNIA

IN-3

NEW LOW SILHOUETTE FANDAIRE AIR-COOLED CONDENSERS

ALWAYS FACED RIGHT —NO MATTER WHAT THE WIND DIRECTION

No need to position circular Fandaire Air-Cooled Condensers to meet prevailing winds. Just set it anywhere for easiest piping.

Exclusive Aimco fintube design provides high-heat dissipating efficiency for circular Fandaire condensers.

Here's the newest, most advanced air-cooled condenser on the market—Fandaire! This modern low silhouette condenser is engineered around a new high-heat dissipating fintube of exclusive design and manufacture. In operation, the entire spiral of fintubing is surrounded with a circle of swiftly moving cool air for highest cooling efficiency. Every degree in temperature drop is fully utilized as this circular design captures the wind from *any* direction, regardless of placement or location. A powerful fan pulls cool air in and pushes warm used air up and away. Fandaire's constant gravity tube drainage gives continuous movement to condensate.

With its low, clean-lined silhouette, Fandaire does not detract from the general architectural effect of the building. And weighing ⅓ less than conventional installations, the Fandaire usually can be positioned where needed, without guy wires or extra bracing. Savings in piping and installation alone may be considerable.

Where there is a problem of architectural compatibility, or of cost or performance, chances are the new Fandaire Air-Cooled Condenser is the best solution. Engineered in sizes from 3 to 120 tons per unit, there is a Fandaire model for practically all single or multiple installations. Get complete information today.

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specialists in circular air-cooled condensers

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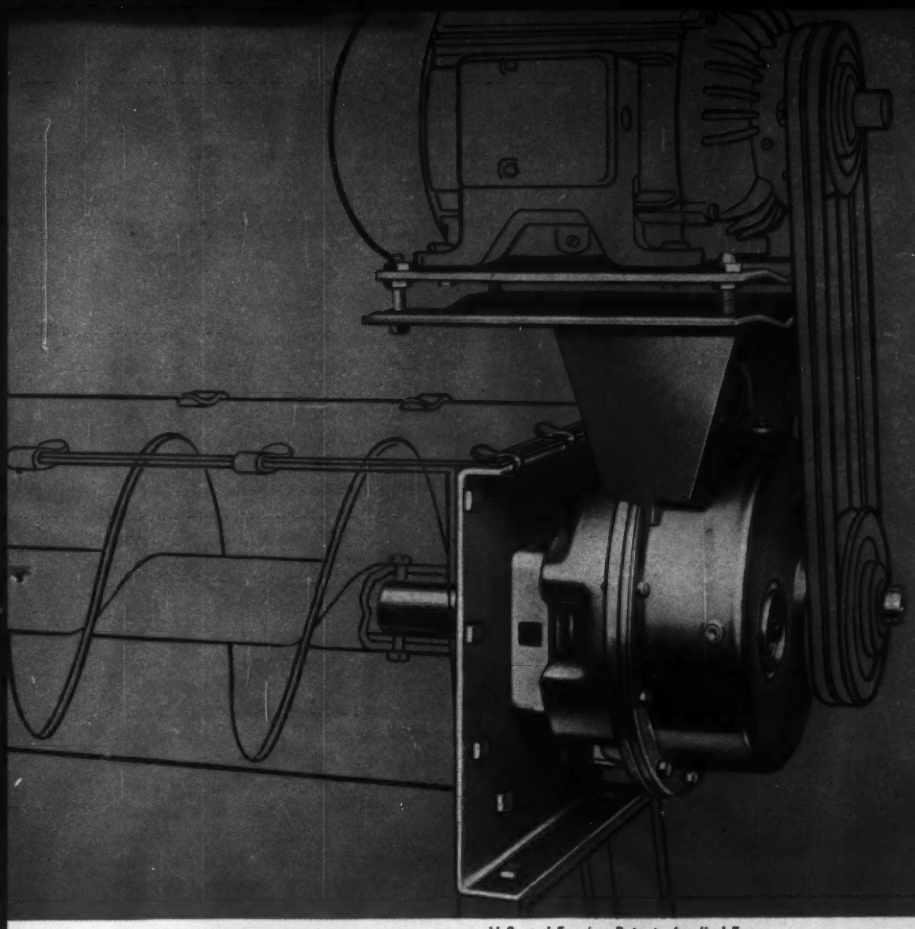


NEW! FALK Screw Conveyor Drive

U.S. and Foreign Patents Applied For

—the drive our customers asked for

Our customers helped us design this new unit. We sent our men into the field to find out what our customers needed in a screw conveyor drive—then our engineers designed a new drive that offers the maximum of service, versatility, operating economy and long life. Here are some of its outstanding features:

A COMPLETE DRIVE: Saves engineering and assembly time. Six sizes to cover entire range—each with these ratios: — 4:1, 9:1, 14:1 and 24:1. Bolts to any standard trough end—eliminates trough end bearing. Eliminates drive shaft wobble. Efficient FALK single helical gears.

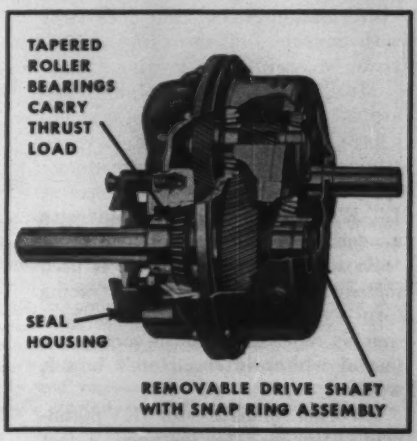
SEAL HOUSINGS: Choice of seals (neoprene or leather lip, felt or waste) to accommodate material conveyed. Space between trough seal and unit seal prevents conveyed material from reaching unit seal.

REMOVABLE DRIVE SHAFT: Snap ring assembly permits easy removal. Five sizes, from 1½" to 3⅞".

TROUGH END: Can be fastened to any standard trough. Eight sizes, from 6" to 20".

ALL-STEEL MOTOR MOUNT: Saves costly engineering and installation time and costs; no motor plates to design or fabricate. Motor can be mounted in virtually any position. Pre-drilled to accommodate NEMA standard motors ½ to 30 HP.

AN IMPORTANT ECONOMY: Buy only what you need—the basic reducer alone, or with trough end and/or motor mount. For detailed information, contact your Falk Representative or Distributor—or ***write direct for Bulletin 7106.***



THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in most principal cities

FALK is a registered trademark

FALK

...a good name in industry

OZALID NEWSLETTER

NEWS AND IDEAS TO HELP YOU WITH ENGINEERING REPRODUCTION AND DRAFTING

Repro room at I-T-E, showing processing of Information Sheets and standard engineering drawings on Ozalid machines. Simple system saves hours of drafting time for the company.

Short-cut system for custom orders

To help turn out "job shop" work at assembly line speed, the I-T-E Circuit Breaker Company of Philadelphia has devised a simple "Information Sheet" that does away with considerable retracing and revising of engineering prints.

More than 70% of I-T-E orders are for custom-designed equipment using standard components. Revising standard drawings to meet customer specs on each order would saddle I-T-E's engineering department with a nearly impossible work load.

So the Information Sheet is used instead. It's an 8½" x 11" tracing form—with printed title blocks—quickly reproduced on the company's Ozalid whiteprinters. Here's how it works:

An order comes in—for 5KV metal-clad switchgear, for instance. A fast freehand sketch of the switchgear is drawn on the Information Sheet. Drawing numbers of standard components and quantity of prints needed are noted on the Sheet.

Then, copies of the Sheet and the required standard drawings are run in the I-T-E repro room. These, with the shop order, go to Manufacturing. When the order is completed, the Information Sheet is returned to the customer file for reference.

This simple short cut with Ozalid whiteprinting saves untold hours of engineering time and gives I-T-E customers faster, more efficient service.

Colors speak louder than words

A simple way to make your security personnel's job a lot easier is to color-code all classified material by using Ozalid sensitized color-copy papers. Colors don't have to be read. Guards can spot restricted or top-secret prints at a glance. Clerks can't make routing mistakes.

To help you devise your own color-coding systems, Ozalid offers papers with eleven image-and-stock color combinations. For example, use black image on yellow stock (instead of traditional blue on white) to code prints of preliminary drawings. Potential uses for color-coding in engineering paper work are virtually unlimited: shop orders, bills of material, spec sheets, change notices, cost estimates, etc., etc.

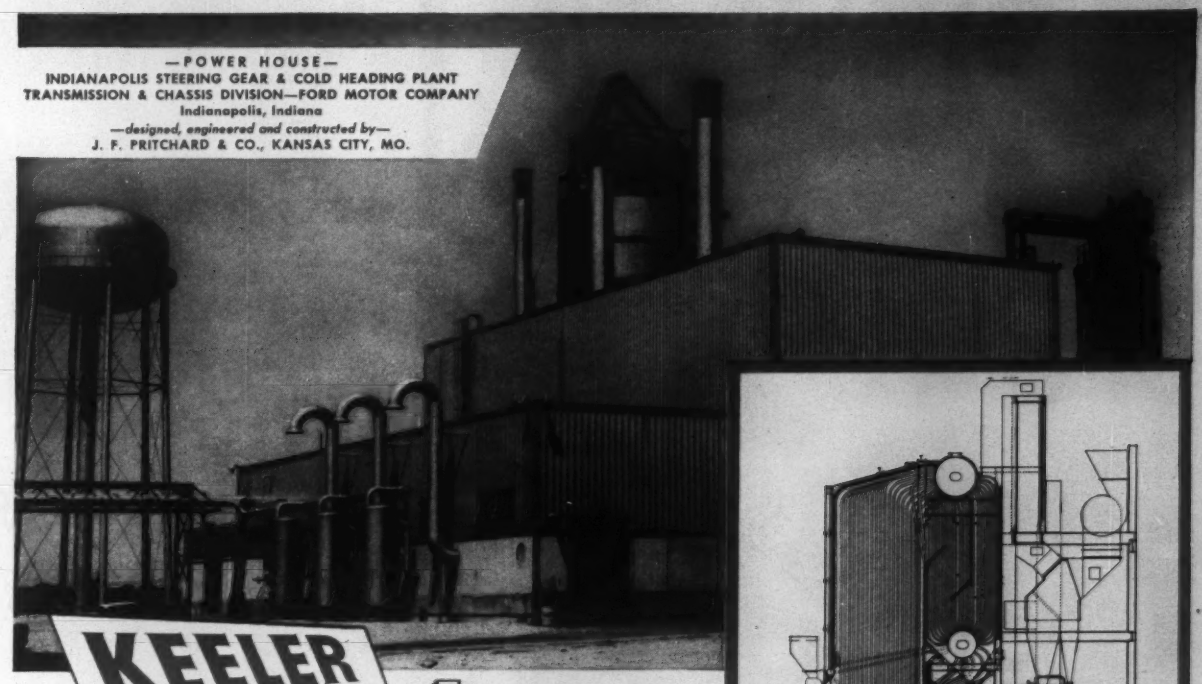
Like a copy of our new Color-Coding Booklet? It tells how a truly versatile, full-range color-coding system can be yours with as little effort as it takes to run prints that are black on white.

Just write to Ozalid, Johnson City, New York. Booklet No. U-2

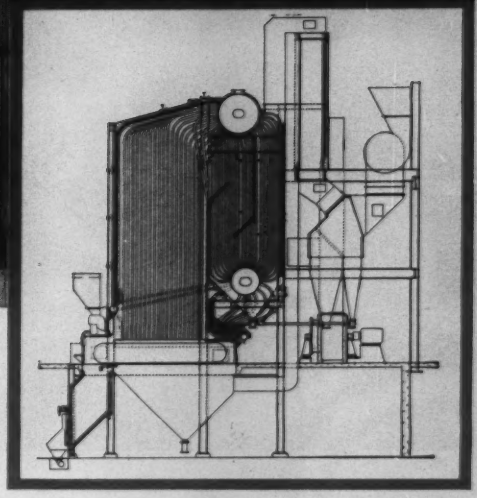
New blue-tint Ozacloth cuts glare, saves eyes

It's bad enough to have *people* glare at you. When your drafting materials glare too, one should take steps. Our research people have—by building a delicate blue tint into our new black-line Ozacloth 101 CZB. It provides excellent contrast between background and dye image—cuts glare, reduces eye strain, makes duplicate originals that are easy to read and work with. Other features? Highest printing speed of any cloth intermediate . . . and a plastic matte surface *on both sides* which accepts pencil, ink or typewriter . . . and keeps sheets from sticking together in files. Write Ozalid at Johnson City, New York, for free descriptive literature on blue tint Ozacloth.

***Ozalid**—Division of General Aniline & Film Corp. • In Canada: Hughes-Owens Co., Ltd., Montreal*



—POWER HOUSE—
INDIANAPOLIS STEERING GEAR & COLD HEADING PLANT
TRANSMISSION & CHASSIS DIVISION—FORD MOTOR COMPANY
Indianapolis, Indiana
—designed, engineered and constructed by—
J. F. PRITCHARD & CO., KANSAS CITY, MO.



KEELER

M K

water tube steam generators

available in capacities from 12,000 to 200,000-lb stm/hr

95 years of design and manufacturing experience provides the basis for steam efficiency and economy at Ford plant

Three Keeler Type M K Steam Generators are serving Ford's Indianapolis Steering Gear & Cold Heading Plant with complete satisfaction on all points. They were selected for their ability to economically deliver 300,000-lb stm/hr for the plant's entire process, heat, hot water and auxiliary equipment requirements.

Two of the M K's are 120,000-lb stm/hr and the other is 60,000-lb stm/hr, 160 psi design pressure. They are equipped with air preheaters and spreader-stokers with continuous ash discharge, for bituminous coal firing—providing as modern and efficient a power facility as the manufacturing plant itself!

Keeler M K Steam Generators offer many efficiency and economy advantages! They are fully top supported, cross drum type with provision for downward expansion to eliminate any stresses being conveyed to the boiler proper, the steam piping or auxiliary equipment. Radiation losses are held to an absolute minimum with water cooled, completely steel encased and insulated furnace walls and roof.

Write or phone for complete information . . . Keeler M K's are available in capacities from 12,000 to 200,000-lb stm/hr—for high efficiency with any firing method or control system.

ONE OF THE NEWEST PLANTS in the Ford Motor Company's Transmission & Chassis Division, the Indianapolis Steering Gear & Cold Heading Plant is Ford's biggest producer of steering gear units for all company cars and trucks, and one of the largest cold heading operations in the world. The main building comprises more than 1,400,000 square feet of floor space—housing production, office and various employee facilities, including a fully staffed hospital and three cafeterias.

The Seal of Quality in Water Tube Steam Generators

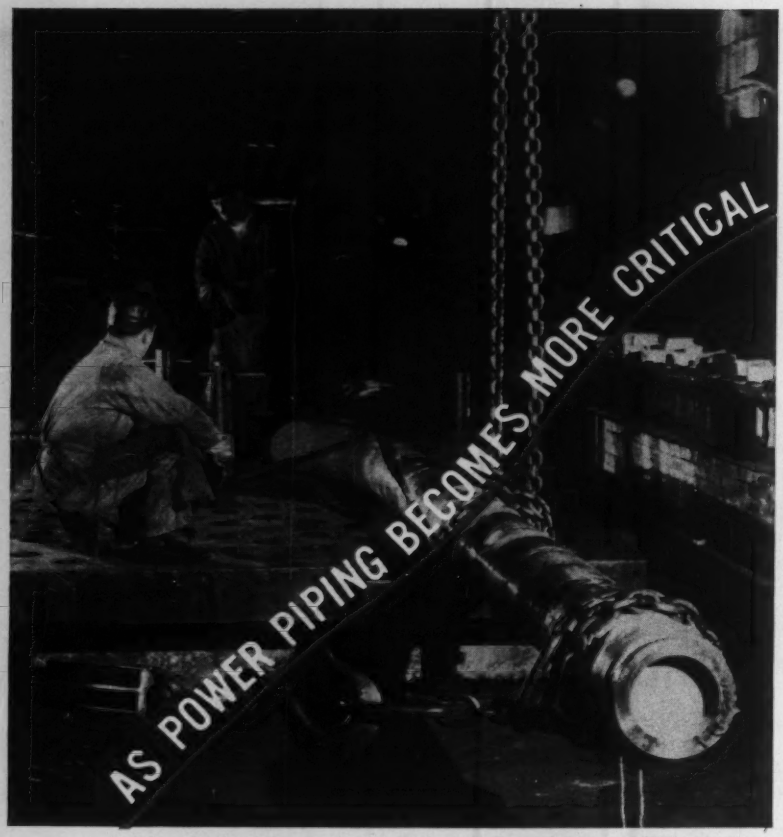
KEELER WATER TUBE Boilers

—ESTABLISHED 1864—

Write For Bulletins

No. MK-1: Type MK Boilers
No. DK-2: Type DK Package Boilers
No. F-14: Type CP Boilers
No. M-2A: Type CPM Package Boilers

E. KEELER COMPANY
400-500 West St., Williamsport, Penna.
—OFFICES IN PRINCIPAL CITIES—
In Canada: Canadian Vickers, Ltd., Montreal, P. Q.



A length of stainless steel piping is bent to close tolerances at Kellogg's Jersey City shops. Dam in pipe end retains inert gas introduced to prevent oxidation.

KELLOGG'S PIPE BENDING TECHNIQUES KEEP PACE

Bending stainless, chrome-moly, and carbon steel power piping to meet exacting specifications of length and wall thickness, as well as contour, is a Kellogg skill reflected in a higher quality and lower cost product.

Among the advanced fabricating techniques pioneered by Kellogg at its Jersey City shops is the use of inert gas to purge pipe interiors of oxygen during the heating and bending cycle. This technique assures freedom from internal scaling and provides a clean interior surface.

By its ability to predetermine bending effects such as pipe wall thinning, cross section variations and pipe stretch, Kellogg maintains specification requirements and top quality while minimizing bending costs.

Kellogg welcomes inquiries on its complete design, fabrication, and erection service to the power piping industry from consulting engineers, engineers of power generating companies, and manufacturers of boilers, turbines, and allied equipment.

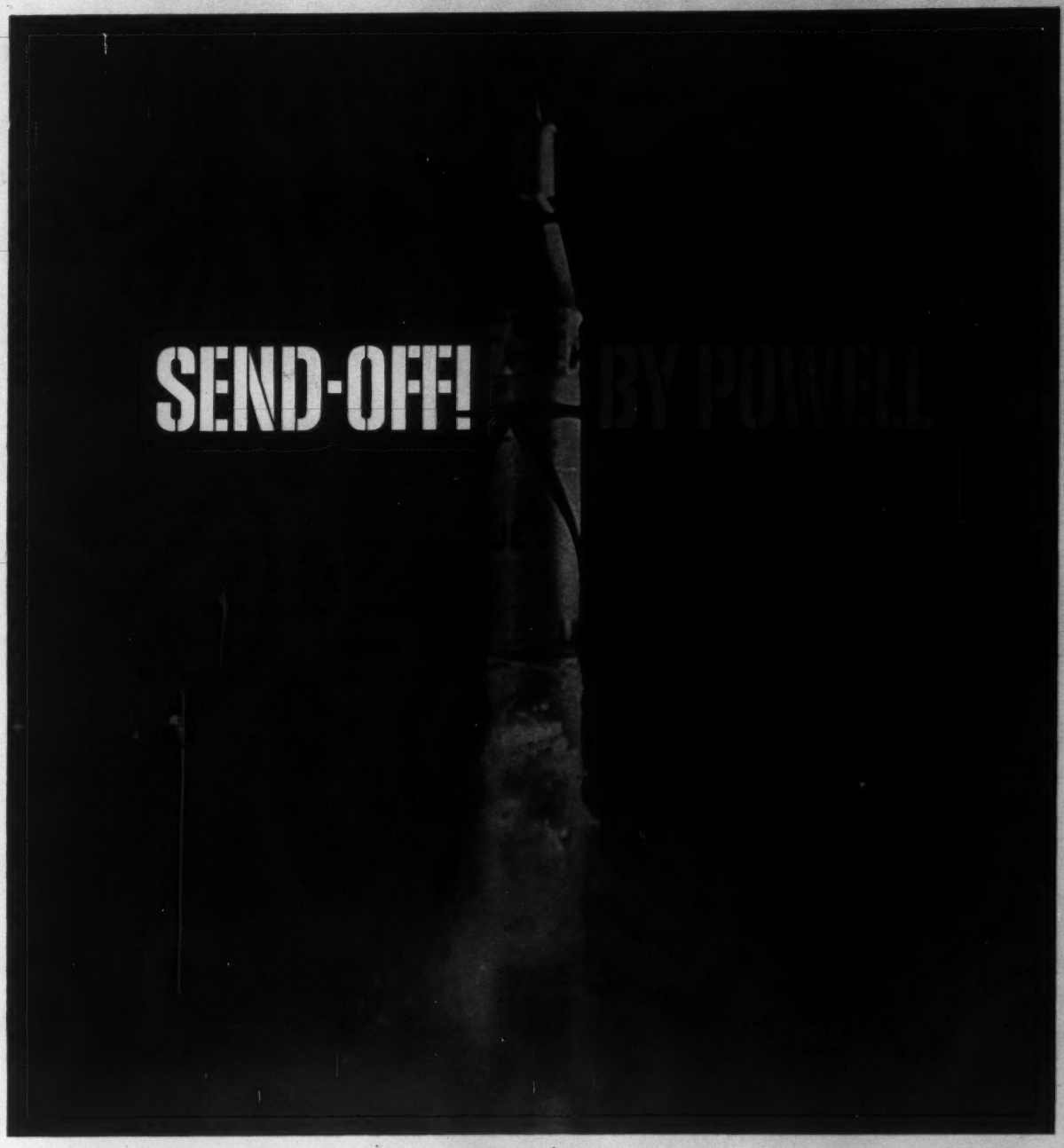
Operator checks pressure of inert gas being forced through piping during heating to prevent internal scaling. Gas is also retained in the piping during bending.

THE M. W. KELLOGG COMPANY, 711 THIRD AVENUE, NEW YORK 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Co., Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., Buenos Aires • Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

POWER PIPING—THE VITAL LINK



Powell Valves control the flow of the propellant fuels in storage and into the missile.

Powell engineers and metallurgists have met this newest valve challenge of our time—by perfecting precision, flawless, never-failing valves for the ground support equipment of our Nation's guided missiles and rockets.

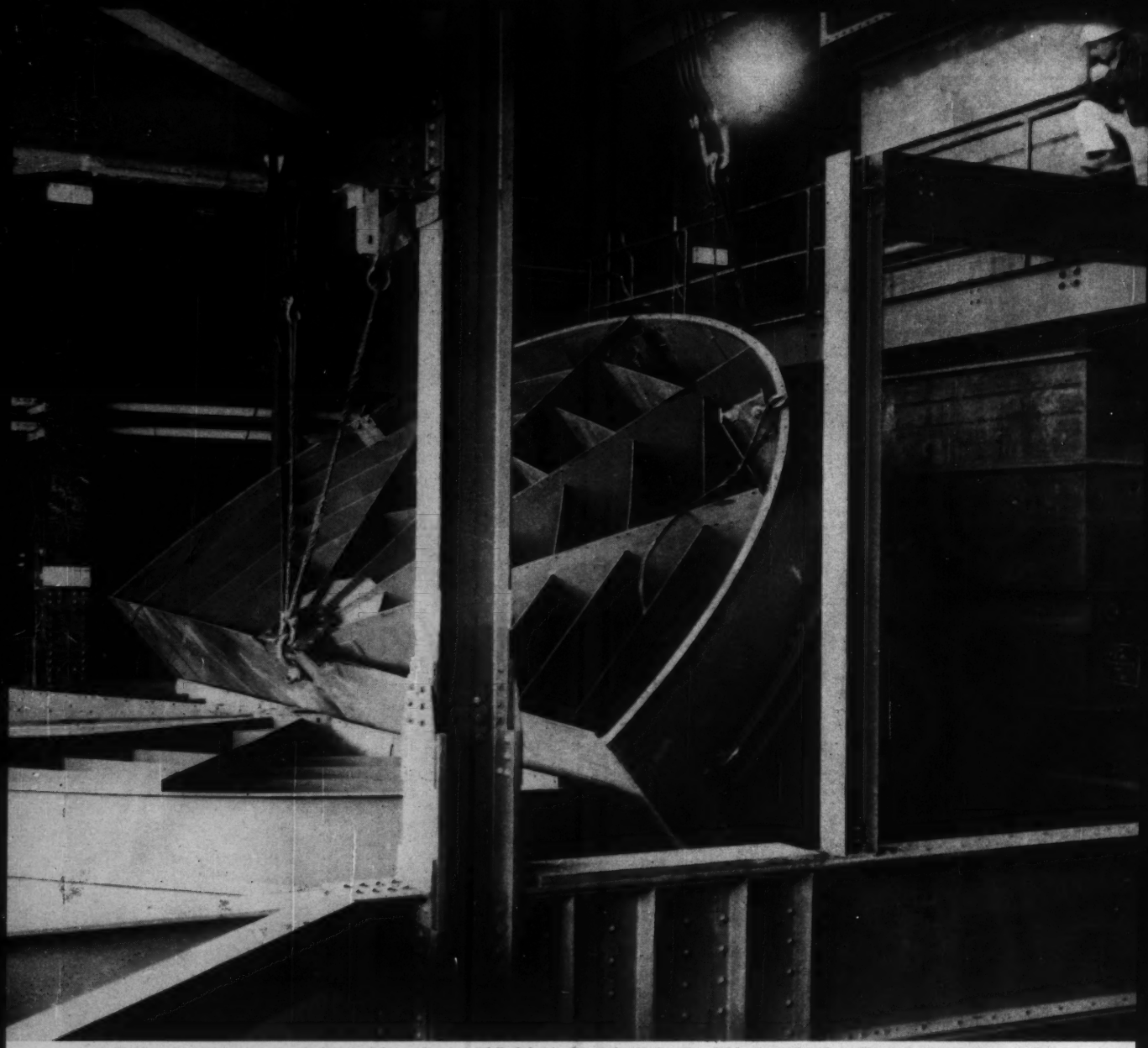
Since 1846, the Wm. Powell Company has been manufacturing vital valves to fill the needs of all industries and reach brave new worlds.

You can count on Powell Valves at the "count-down" in your industry for handling water, oil, gas, air, steam, corrosive fluids, or fuels. Contact your nearest Powell Valve distributor. And for complete information on Powell Valves in the United States missile program, write directly to us.

world's largest family of valves

POWELL VALVES

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO



Half of Ljungstrom rotor is lowered into place at Philadelphia Electric Co.'s new Eddystone Station. When heating element baskets are fitted into the rotor chambers, this unit will provide 201,100 sq. feet of heat transfer surface and will weigh about 535,000 lbs. It will be one of four air preheaters serving a 325,000 KW unit. Two such boiler units are presently being installed.

SAFEGUARDING EDDYSTONE'S **NEW LJUNGSTROMS®** **—LIFETIME AIR PREHEATER SERVICE**

Dependability is standard equipment in Philadelphia Electric Co.'s new Ljungstroms. Each unit is protected by Lifetime Air Preheater Service. That means that *throughout the life of each unit,* Air Preheater engineers make regular calls to inspect the Ljungstroms and keep them in top operating condition.

Air Preheater also shows lively, consistent interest in their *factory* service to customers. For example, when a midwest customer recently ordered emergency replacement elements, Air Preheater's traffic department investigated the cost, speed and control of all commercial shipping methods. In the circumstances, regular trucking would take too long, rail delivery was impractical, other methods prohibitively expensive.

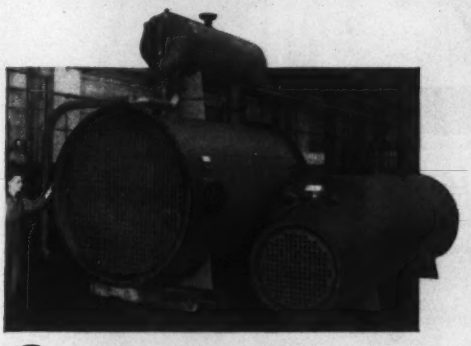
So Air Preheater asked for authorization to ship the replacement elements aboard one of their own trucks. The result: the elements arrived a week in advance of the hoped-for date — and, thanks to Air Preheater's efforts, the customer made significant savings on transportation costs.

In addition to regular field service and fast, competent factory service, Air Preheater offers you over 35 years of experience in solving boiler and preheater problems. These reasons help explain why 19 of the 20 most efficient power stations in the U.S. are Ljungstrom-equipped.

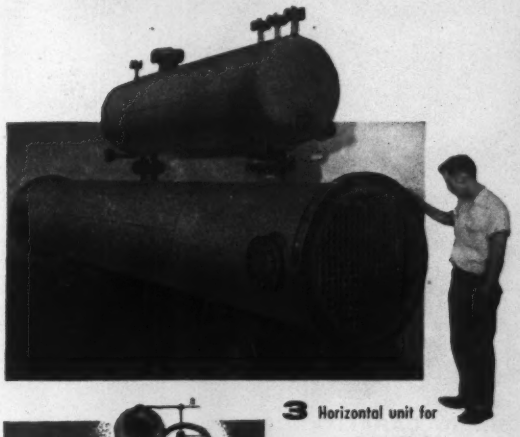
THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

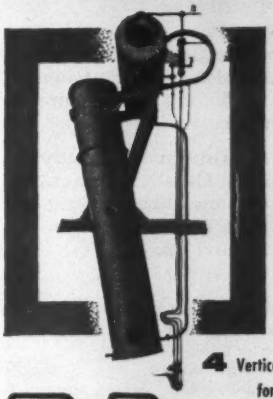
1 A nitric acid plant installed this unit. It has a built-in platinum catalyst chamber.



2 A methanol plant operates these horizontal type units.



3 Horizontal unit for a nitric acid plant.



4 Vertical type unit for a hydrogen plant.

5 TYPES OF Waste Heat STEAM GENERATORS

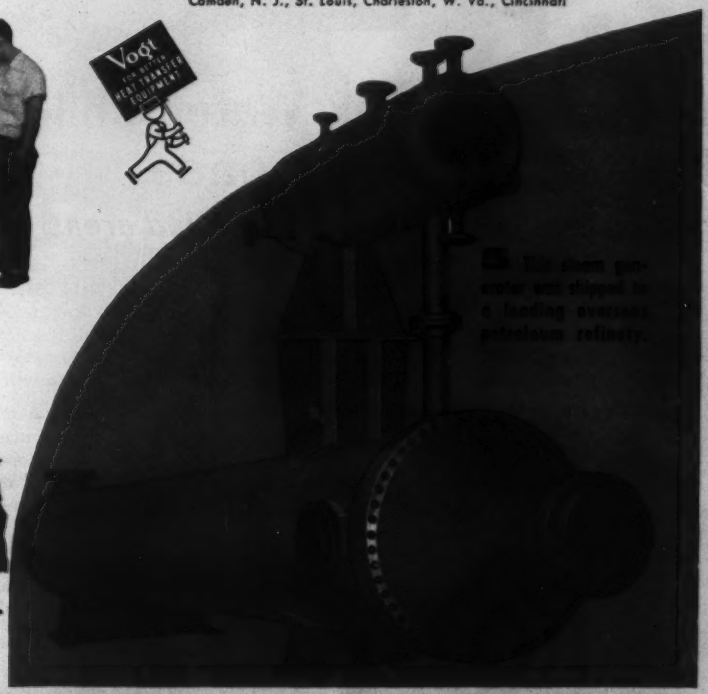
Each of the units shown were custom designed to solve the specific problems peculiar to individual plant processes.

Vogt engineers are available to help you develop the right equipment to efficiently provide low cost steam from process heat. There's no obligation.

Write for Literature—Address Dept. 24A-XM

HENRY VOGT MACHINE COMPANY
LOUISVILLE, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati



5 This steam generator was shipped to a leading overseas petroleum refinery.

Vogt HEAT TRANSFER EQUIPMENT

YORK Turbopak Water Chiller Takes 50% Less Space

—Fits into confined, often-wasted areas

COMPACT, HERMETIC CENTRIFUGAL—A 130-ton Turbopak is only 14′ long, 5′ deep and 6¾′ high, nearly 50% smaller than previous designs. Exclusive Borg-Warner power transmission reduces compressor rotor size to gain space-saving compactness.

COMPLETELY FACTORY PACKAGED—To cut installation costs, the Turbopak is completely factory assembled, insulated, piped, wired, charged, tested. It's shipped and rigged as a single unit—no assembly or refrigeration piping on the job.

AUTOMATIC CAPACITY CONTROL—Pre-rotation vanes provide efficient capacity reduction to 5% of full load. This continuously variable control matches compressor capacity to air conditioning load, assuring maximum system performance.

ULTRA-QUIET OPERATION—Runs more quietly than water pumps that supply it. Quiet, vibration-free operation permits location anywhere. "Push-button" controlled from convenient electronic control center. 65 tons refrigeration and up.

Another YORK Trail Blazer Concept Proved in Action at *Insurance Company of North America, Richmond, Indiana*— A 125-hp York Hermetic Turbopak supplies chilled water to air condition this modernized office building. Cool, clean, dehumidified air greatly increases the comfort and efficiency of the employees.

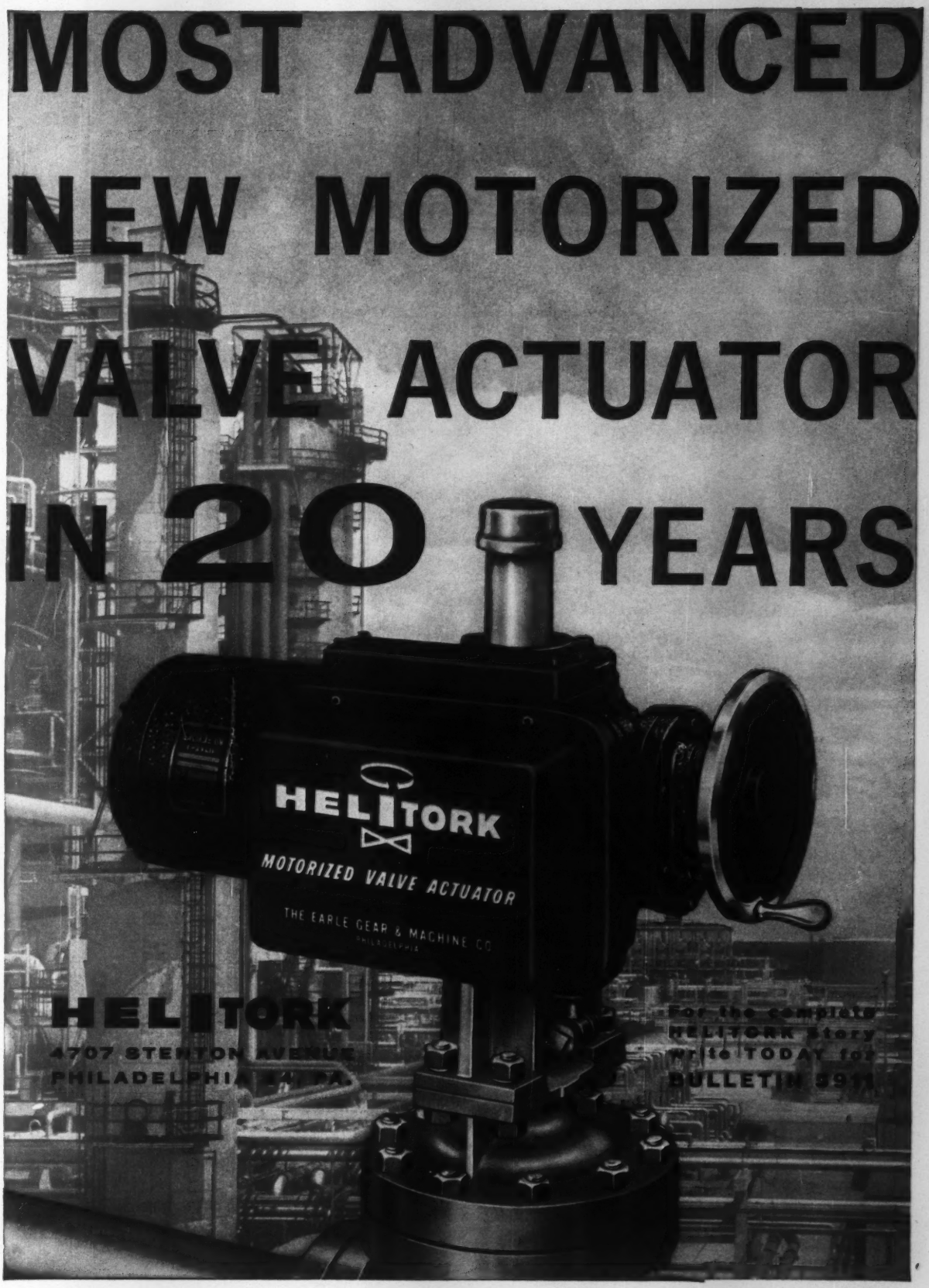
YORK BW DIVISION

YORK CORP., SUBSIDIARY OF BORG-WARNER CORP.
5402 WEST GRANTLEY RD., YORK, PENNSYLVANIA

BORG-WARNER
RESEARCH & ENGINEERING
MAKE IT BETTER

Air Conditioning, Heating, Refrigeration and Ice-Making Equipment • Products for Home, Commercial and Industrial Applications

MOST ADVANCED NEW MOTORIZED VALVE ACTUATOR IN 20 YEARS



HELITORK
4707 STENTON AVENUE
PHILADELPHIA 44, PA.

For the complete HELITORK story write TODAY for BULLETIN 5911

BONUS

from the Boiler

POWER

Capital of the World

THE TITUSVILLE

BONUS POWER means maintained high efficiency . . . longer life . . . low maintenance . . . more horsepower per total energy input. That's what you get when you install a complete TITUSVILLE-ATLAS unit, the only boiler with a patented wet back.

Wet-back design gives you maintained efficiency by eliminating back end refractories. *Result:* no down time for replacement.

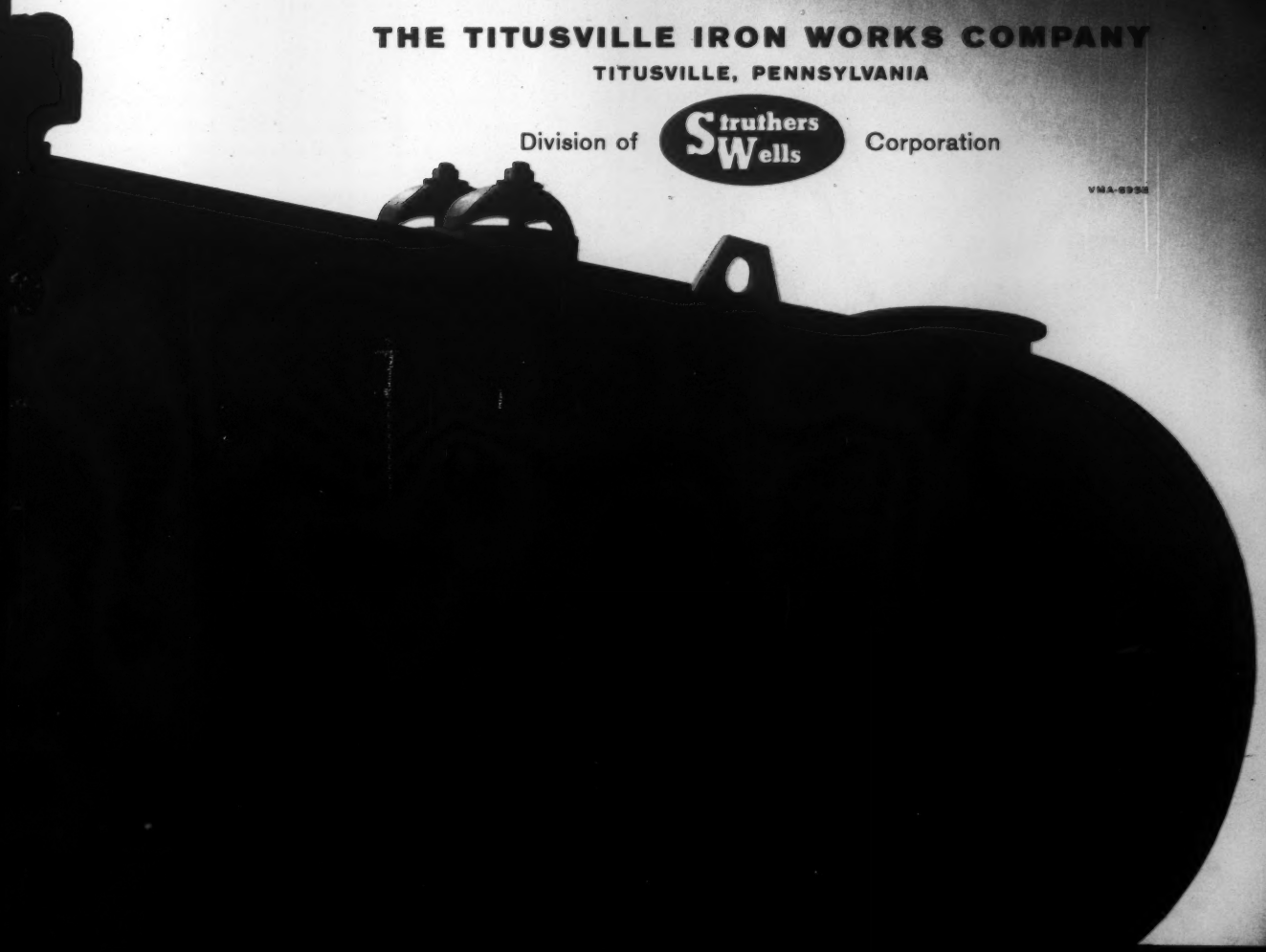
Larger furnace area permits reduced fan requirements. *Result:* lower operating costs. Get BONUS POWER. Specify TITUSVILLE-ATLAS.

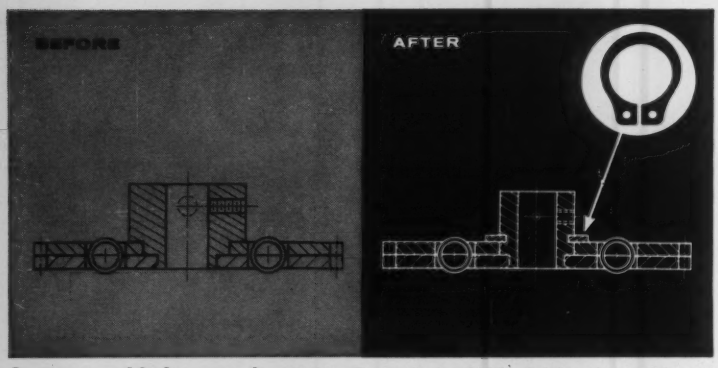
THE TITUSVILLE IRON WORKS COMPANY

TITUSVILLE, PENNSYLVANIA

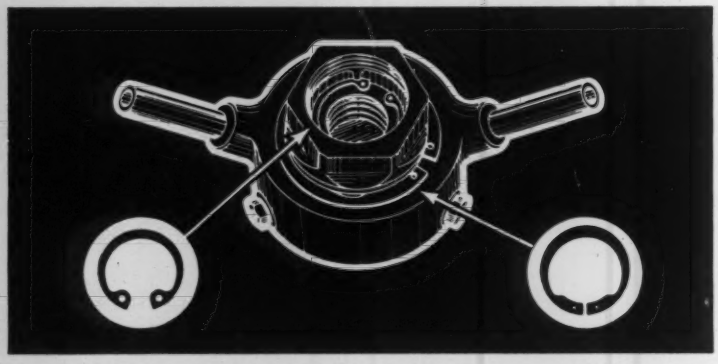
Division of Struthers Wells Corporation

VNA-6938

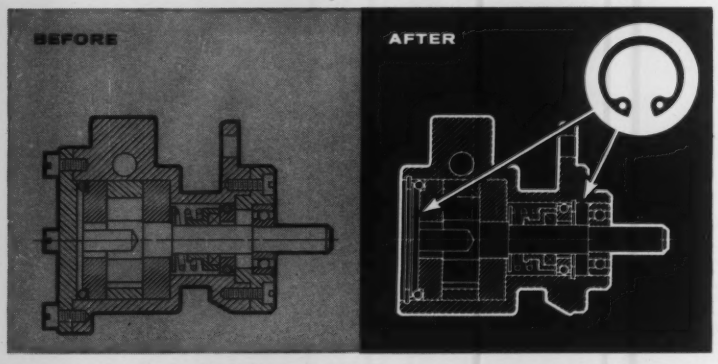




Gear assembly improved. A Waldes Truarc Series 5100 retaining ring in this anti-backlash gear assembly eliminates machining and staking operations, reduces hub size, and allows easy disassembly, after gears are cut as a unit, for faster, better deburring. **Typical savings: $350.00 per 1000 units.**



Threaded retainers eliminated. In this self-sealing coupling, costly internal and external threaded retainers were eliminated by easy-to-apply internal (Series 5000) and external (Series 5108) Truarc retaining rings. **Savings per unit amounted to $4.02.**



End-cover design simplified. In this general-purpose pump, two Waldes Truarc, Series 5000, internal retaining rings make possible the elimination of two cover-plate castings (plus machining) and eight screws (plus drilling and tapping). Weight and dimensions are reduced and assembly and disassembly are greatly facilitated. **Typical cost savings: $1.48 per unit.**

©1959 WALDES KOHINOOR, INC.

WALDES
TRUARC®
RETAINING RINGS
Waldes Kohinoor Inc., Long Island City 1, N. Y.

Designing for axial assembly with Truarc retaining rings

eliminates parts, machining, speeds assembly, simplifies maintenance

The proper application of retaining rings on or in axial assemblies can often effect startling simplifications and economies in design when compared to corresponding designs with conventional fastening devices. A few typical examples, using basic types of retaining rings, are shown in the accompanying drawings.

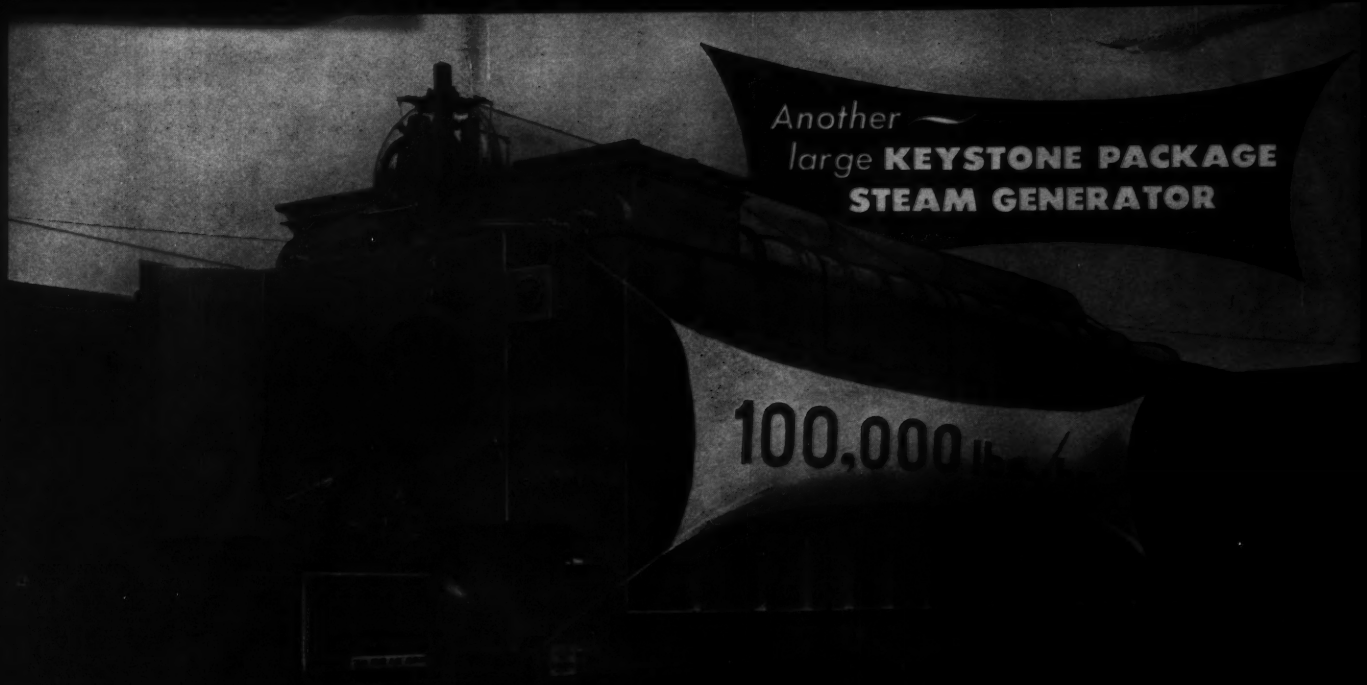
Threading, tapping, drilling, facing and other costly, time-consuming operations can be eliminated. Retaining rings are already in wide use in a tremendous variety of equipment ranging from household products to high-precision military gear designed for use under the most severe environmental conditions. They are quickly and simply installed in easily cut grooves which can often be machined simultaneously with other operations. The rings can frequently replace bulkier, more costly fastening devices —such as nuts, screws, studs, threaded sleeves and retainers, cotter pins, set collars, rivets and machined shoulders.

What's more, rings frequently make practical designs which could be achieved with no other known fastening device.

Although the ring types shown here are basic, Truarc retaining rings come in 50 functionally different types, as many as 97 different sizes within a type, 6 metal specifications and 13 finishes. You'll find detailed descriptions of Truarc retaining rings and assembly tools, plus more than 70 typical applications in the new 24-page catalogue RR10-58. Write for your copy today.

And remember, Waldes engineers are always ready to help you solve your application problems—whether it involves one of the standard Truarc rings or a "special" to fit your particular requirements. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y. 9.1

TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS



This Natural Circulation KEYSTONE for Amalgamated Sugar Company, Nyssa, Oregon

Other Recent Users of Large Capacity Keystones

- **90,000 lbs./hr.**
  The Bay Petroleum Corporation
  Chalmette, Louisiana
- **80,000 lbs./hr.**
  Oregon Pulp and Paper Company
  Salem, Oregon
- **70,000 lbs./hr.**
  McDonnell Aircraft Corporation
  St. Louis, Missouri
- **60,000 lbs./hr.**
  Bethlehem Steel Corporation
  Sparrows Point, Maryland

The Keystone design was developed in the 1940's for engineers who demand top performance in water tube package steam generators. Unique features of this design make the Keystone the wise choice of engineers who specify and buy package boilers.

- **Symmetrical Design** — Easy to unload — easy to move.
- **Tangent Furnace Tubes** — No troublesome fins or studs required to form furnace or outer walls.
- **Tangent Outside Tubes** — Plus steel jacketed insulation for minimum heat loss.
- **Welded Inner Casing** — Eliminates casing corrosion problems.
- **Light Weight Insulation** — No heavy refractory tile to increase shipping weights.
- **Bolted Outer Casing** — No cutting or patching required when inspection is desirable.
- **Undivided Responsibility** — Firing equipment designed and manufactured by Erie City Iron Works.
- **Minimum of Maintenance** — No baffles — headers — key cap or handhole plates.

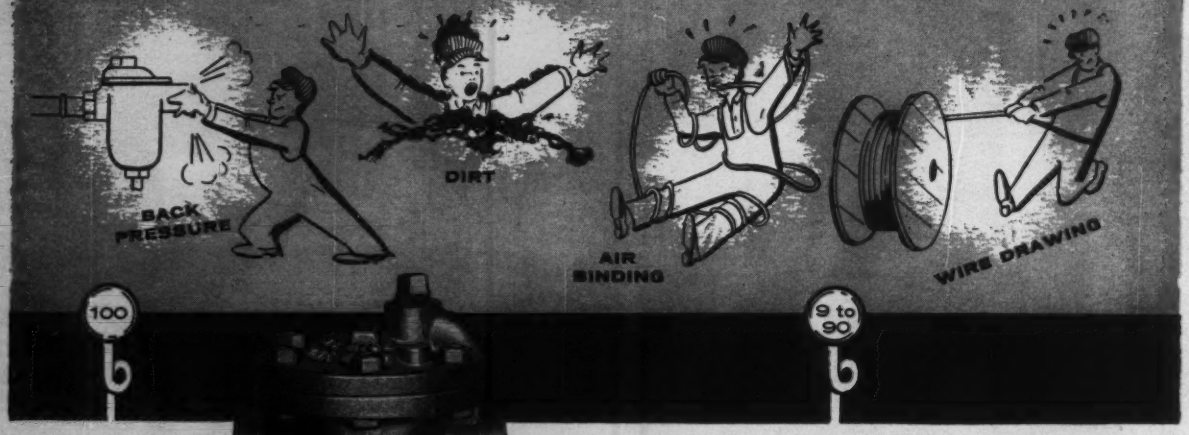
Keystones use only tubes for heating surface. No fins, studs or other extended surfaces of questionable value are used. The Keystone packs more real heating surface in the smallest space resulting in lower exit temperatures and highest efficiencies. *Get the details in Bulletin SB-5903-B.*

You can depend on ERIE CITY Since 1870 *for sound engineering*

ERIE CITY IRON WORKS · Erie, Pa.

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS • WASTE HEAT BOILERS
FIRE and WATER TUBE PACKAGE BOILERS • OIL and GAS BURNERS • STOKERS • PULVERIZERS

Have you ever been troubled by any of these steam trap problems?



ARMSTRONG STEAM TRAPS are designed and made to eliminate these problems

BACK PRESSURE . . . Armstrong Traps operate on any back pressure—or vacuum, for that matter. As long as there is a pressure differential across the trap, it will close on steam and open for condensate. Even the high back pressure caused by blow through of one or more traps in the system will not disturb Armstrong Traps. Other than a reduction in capacity, Armstrong Traps are unaffected by back pressure.

DIRT . . . Armstrong Traps are not affected by ordinary dirt. When the trap opens condensate swirls down under the edge of the bucket and up through the discharge orifice. Dirt is kept in suspension and discharged along with the condensate. For very bad dirt conditions, Armstrong offers traps with integral strainers. These cost less than a trap plus a separate strainer.

AIR BINDING . . . Armstrong Traps cannot air bind. Air in the system passes through a vent in the top of the bucket. It collects in the top of the trap and is discharged with the condensate. There is no chance for it to stop the trap. For low pressure on-and-off units where large amounts of air accumulate while the steam is off, Armstrong offers open float and thermostatic air vent traps in a complete range of sizes.

WIRE DRAWING . . . Armstrong Traps are designed and made to resist wire drawing. The valve and seat are tough stainless steel. The valve opens and closes tightly with a fast action and is always water sealed. There is virtually no chance for grit or sediment to lodge in the valve, virtually no chance to create conditions that lead to wire drawing.

There's no need to accept any of these problems as "inevitable." Your local Armstrong Representative can show you how to end them all. Call him today or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

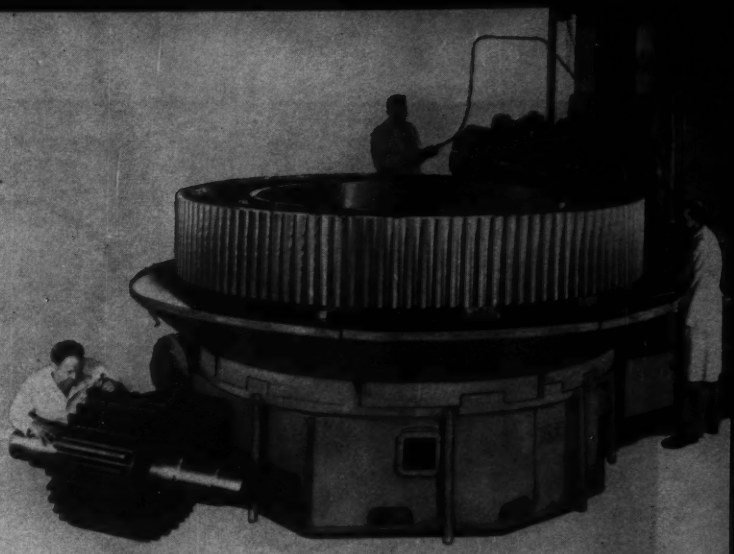
The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

8941 Maple Street Three Rivers, Michigan

"See Our Catalog in Sweets Plant Engineering File"

GEARS FOR EVERY PURPOSE

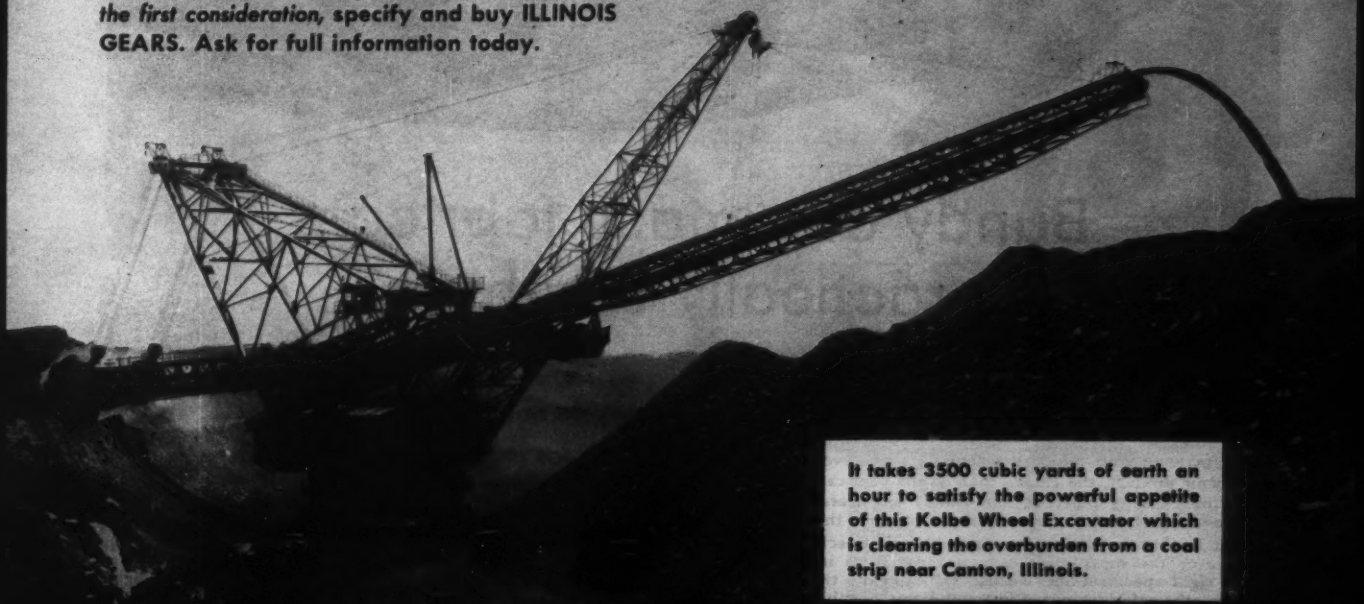


Machining the large spur gear for driving the digging wheel of the huge Kolbe Excavator.

Throughout the world—wherever gears are used—ILLINOIS GEARS have a matchless reputation for dependability and superiority that is constantly being proven by their performance in such equipment as this mammoth Kolbe Wheel Excavator designed by the United Electric Coal Companies.

One can well imagine the enormity of engineering work required to design and build this giant earth mover and the responsibility of the components which include numerous ILLINOIS GEARS, in assuring its successful operation.

If you want gears that are made right, *with quality as the first consideration,* specify and buy ILLINOIS GEARS. Ask for full information today.



It takes 3500 cubic yards of earth an hour to satisfy the powerful appetite of this Kolbe Wheel Excavator which is clearing the overburden from a coal strip near Canton, Illinois.

Look for this mark (ILLG) *. . . the symbol on finer gears*

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Gears for Every Purpose **... one gear or 10,000 or more**

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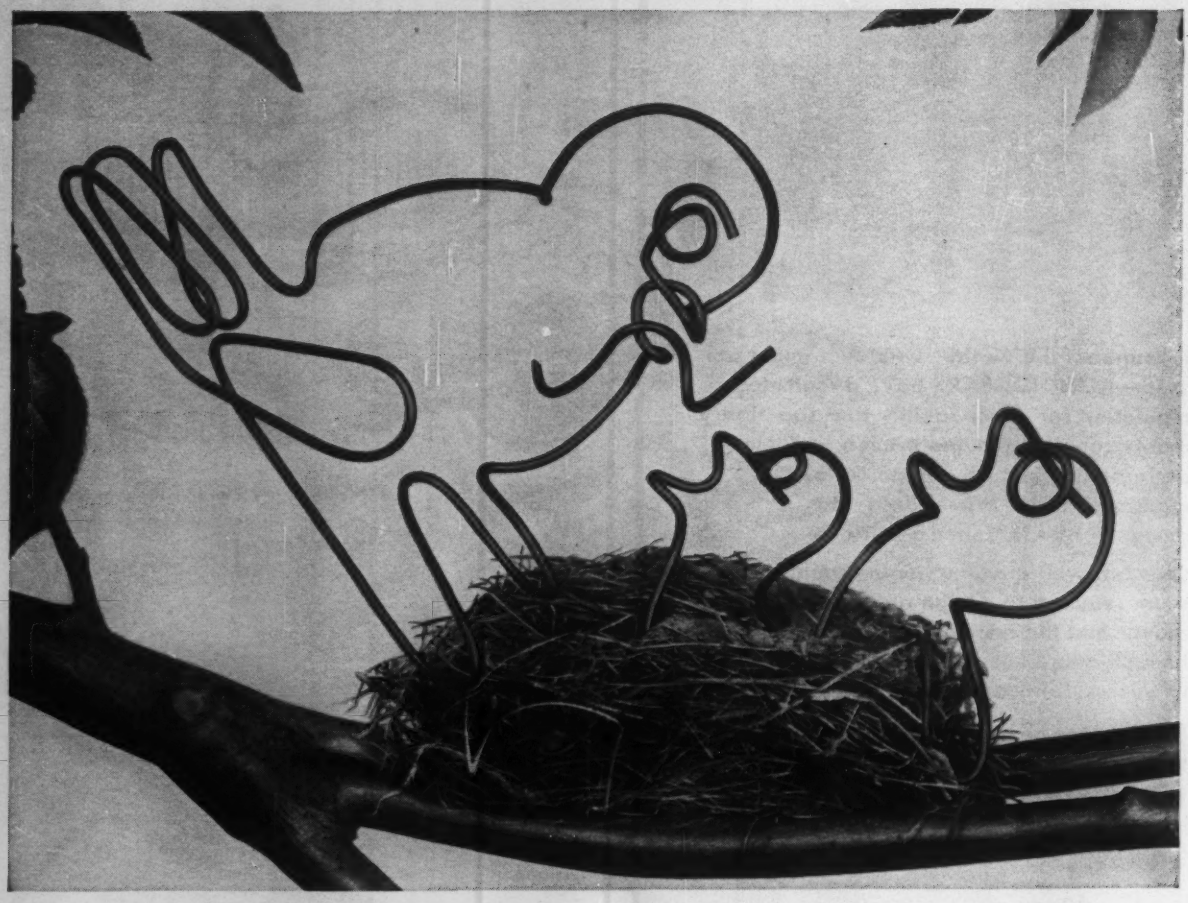


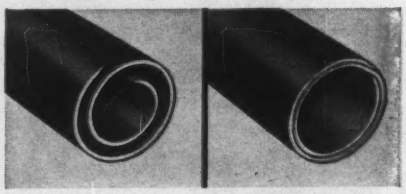
Bundy can mass-fabricate practically anything

. . . with Bundyweld® — double-walled steel tubing that is adaptable to a whole host of applications.

WHATEVER your tubing problems . . . whatever the stage of development of your product, the Bundy man awaits your call. That's because tubing problems are Bundy's business, and Bundy engineers — with years of tubing experience — can often come up with a design angle that'll save you time and money.

But the Bundy service doesn't end there! Specially designed Bundy machines take over the mass-fabrication of these parts in unlimited quantity. And to meet rigid specifications, we use Bundyweld — the original double-walled steel tubing—the safety standard in small diameter tubing. Thinner-walled Bundyweld is stronger and gives you higher bursting and fatigue strengths. Covered by Government Spec. MIL-T-3520, Type III.

Why not bring your tubing troubles to Bundy and take advantage of expert engineering and design, mass-fabrication economies, and Bundyweld tubing? See Sweet's Product Design File le/Bu . . . or write directly for full information! Bundy Tubing Company, Detroit 14, Michigan.



Bundyweld is the original tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

There's no substitute for the original Bundyweld Tubing.

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HOMETOWN, PA. • DETROIT 14, MICH. • WINCHESTER, KY.

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY

Automatic marking of hot steel . . .

A-B

Controls by ALLEN-BRADLEY, of course

Here's an interesting job that's gone "push button"—stamping heat numbers on hot steel! Now, from a remote console, the operator automatically sets numbers on the marking head and propels it against the steel. The controls, *of course*, are Allen-Bradley because they provide the continuous reliability that is essential to this production.

The simple, ONE moving part solenoid design of A-B starters and relays assures millions of trouble free operations. And the double break, silver contacts—used on all A-B control—eliminate costly downtime for maintenance. Keep your production lines rolling . . . insist on Allen-Bradley *quality* motor control. You cannot do better!

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Quality Motor Control

The relays and push buttons used in the remote control console of this M. E. Cunningham Marking Machine are all standard Allen-Bradley catalog items.

750-HP turbo-gear unit with double ended low-speed gear shaft—for installation in center of paper machine line shaft.

LOW-SPEED TURBINE DRIVES

tailored to meet your requirements

For more than half a century, Terry has been one of the principal suppliers of turbo-gear units for driving slow-speed fans, generators, paper machines, large pumps and the like. Each unit is designed to meet the job requirements. The paper-machine drive illustrated is a good example of this *individualized engineering.*

In service at a large southeastern paper mill, the unit delivers 750 HP at 3350/500 RPM, with steam conditions of 450 lbs., 660°F and 50 lbs. back pressure. Equipped with a variable-speed governor, operated by remote control, the speed of the unit may be varied through a 10:1 range. Other features include forced-feed lubrication to turbine and gear bearings, and automatic shutdown and alarm in case of low oil pressure.

Whatever *your* requirements for low-speed turbine drives, a Terry engineer will be pleased to discuss them with you. Bulletin S-140 covers the full line of Terry turbines; Terry gears are described in bulletin S-130.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

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Do you need pressurized air for jobs like these?

- Oil or Gas Furnace Blowing
- Cupola Blowing
- Gas Line Boosting
- Exhausting from Grinding Wheels

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"BUFFALO" TYPE "E" BLOWERS AND EXHAUSTERS

Wherever you need constant air pressures up to 5500 cfm, these dependable "Buffalo" Blowers will do the job most efficiently and economically. Compact, ruggedly-built, direct-connected "Buffalo" Type "E" Blowers and Exhausters are available in eight sizes. Pressures up to 2 lbs. mean you can choose the units exactly suited to your needs.

Various special features are available, including flanged inlet, flanged outlet, stuffing box around the shaft for gas-tightness. For corrosive fume handling, housings can be coated with Bisonite or Heresite. Housings may also be cast of special metals. Stainless steel, Everdur, brass or aluminum wheels are available. Used in multiple, these units are more flexible and economical than a single large blower.

For full information on "Buffalo" Type "E" Blowers and Exhausters, contact your "Buffalo" engineering representative—or write us for Bulletin FMB-935. Other units suitable for higher pressures are the type RE and type CB blowers.

"Buffalo"

BUFFALO FORGE COMPANY
Buffalo, N. Y.
Buffalo Pumps Division, Buffalo, New York
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

here's the really new

Cleveland Worm and Gear

SPEED REDUCER

It was Designed to Provide: High Horsepower in a Smaller Unit • Centrifugally Cast Bronze Gears • Alloy Steel Worms Heat Treated By An Exclusive Process for Carrying Higher Loads • Fan Cooling for More Efficient Operation • Maximum Overhung Load-Carrying Capacity • Ribbed Housing for Maximum Strength and Heat Dissipation • Modern, Streamlined Design to Enhance Your Machine's Appearance.

Cleveland's new speed reducer line meets AGMA Standard 440.03 — which permits higher horsepower and torque ratings — provides you speed reduction at savings of 50% or more on cost per horsepower. All this, with no deviation from Cleveland's standards of quality and dependability.

Remember, this strikingly new line of fan-cooled reducers — now available from one to forty horsepower — incorporates all the design knowledge gained by Cleveland's engineers over the past 47 years — plus all the advantages of modern metallurgical techniques and advanced manufacturing processes. Consult your Cleveland Representative for the complete story on this new speed reducer — or write us direct for Bulletin No. 405. It details input horsepower and output torque ratings, service factors, application and load classifications, as well as general over-all dimensions. **The Cleveland Worm & Gear Company, 3264 East 80th Street, Cleveland 4, Ohio.**

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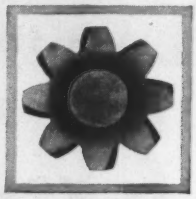
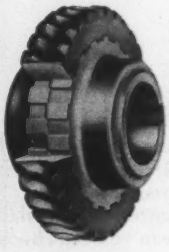
CLEVELAND
Worm Gear
Speed Reducers

Check these new exclusive Cleveland features

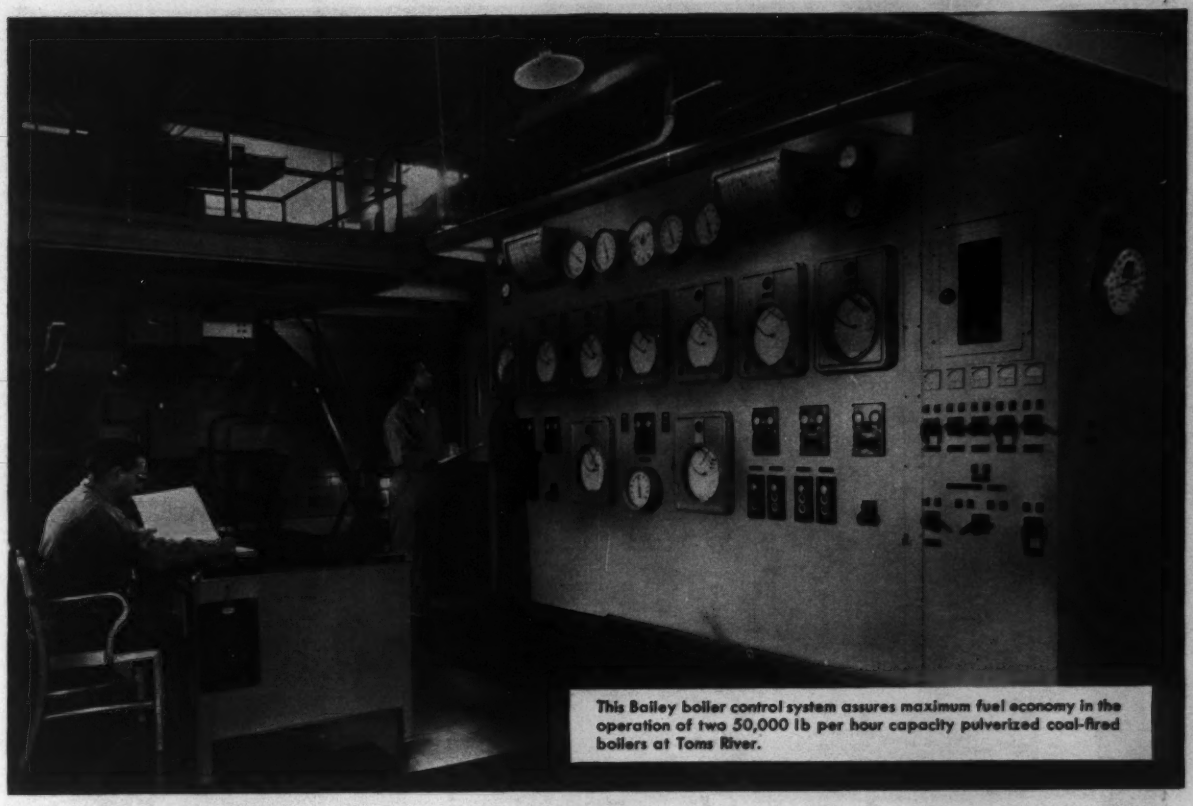


Cleveland's Worm's, heat-treated by an exclusive process, possess a high degree of hardness throughout their entire thread thickness — and well below the worm's root diameter. This gives maximum thread strength and resistance to wear without losing the advantage of a tough core of medium hardness.



Centrifugal cast bronze rims have a greater density and a higher hardness, giving increased resistance to wear and fatigue pitting. They are centrifugally cast integral with cast iron centers on 6" and smaller sizes. This permits strong mechanical keying of the two parts — without dependence on actual surface bond. Gear shaft extension diameters are especially large to permit greatly increased overhung load capacity.

Worm and gear shaft bearings are Timken taper roller type, providing adequate thrust and radial capacity. Worm bearings are mounted directly in the housing bore for greater rigidity.



This Bailey boiler control system assures maximum fuel economy in the operation of two 50,000 lb per hour capacity pulverized coal-fired boilers at Toms River.

How Bailey helps control STEAM COSTS AT TOMS RIVER

With a Bailey-engineered control system you can count on a high output of available energy per unit of fuel, whether you operate a small industrial boiler or a large central station boiler.

They did at Toms River — Cincinnati Chemical Corporation's plant in Toms River, N. J.! Bailey Controls help them save fuel by continuously maintaining desired operating conditions.

Most high-efficiency steam generating plants rely on Bailey because:

1. A Complete Line of Equipment

Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion and automatic control are your assurance of the best possible system.

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Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

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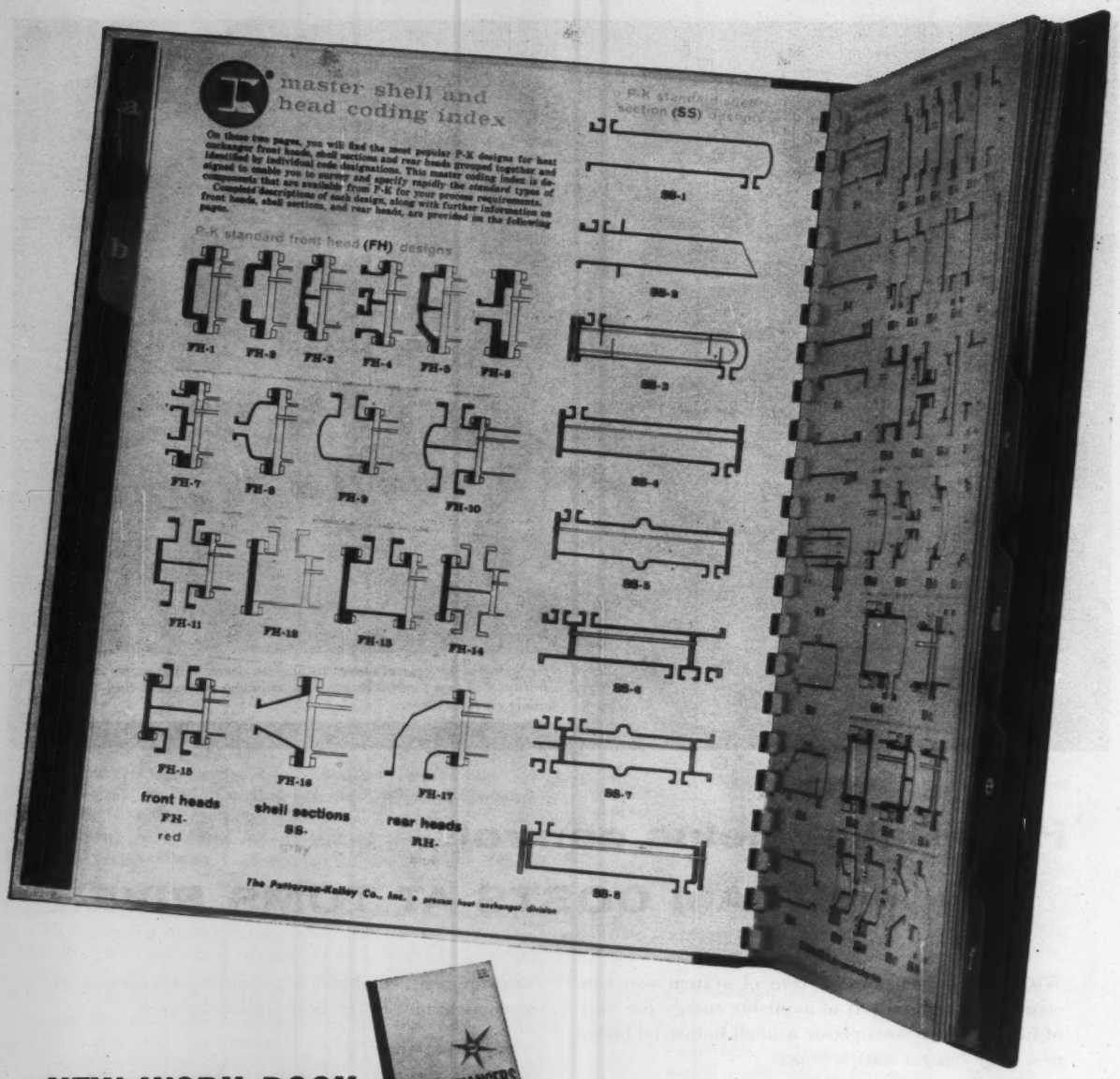


NEW WORK BOOK SIMPLIFIES HEAT EXCHANGER SELECTION

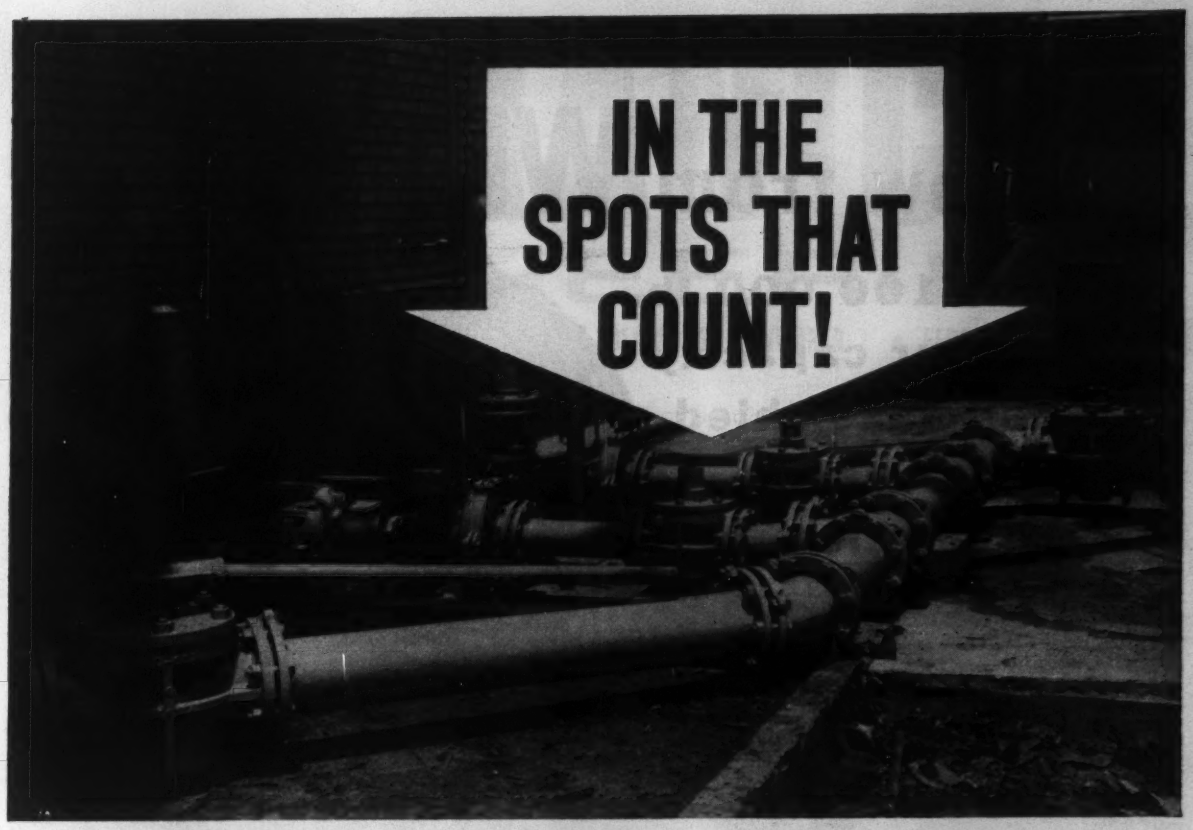
The need for a standard terminology to simplify communications between P-K and engineers in the chemical processing industry has been met in P-K's new Heat Exchanger Manual.

This unique communications tool illustrates and describes components of shell and tube heat exchangers commonly used in processing. A complete system of interchangeable front heads, shells and rear heads is established. Fundamentals of heat transfer and design are reviewed. Even economic considerations are discussed. The simple, certain nomenclature saves time, effort and duplication of engineering work.

This 120-page manual, indexed and bound in hard covers, will be supplemented from time to time with new technical material. Names of holders will be registered to receive such material as it appears.

Only a limited number of copies is available and, naturally, these should go to those in the process industries who will benefit most from the information we have compiled. If you design or specify heat exchangers, write us on your company letterhead, outlining briefly areas of your interest. A few copies are available to students and non-technical personnel at a nominal charge. Patterson-Kelley Co. Inc., E. Stroudsburg, Pa.

Patterson Kelley
Heat Exchanger Division



Goodyear specifies Homestead Valves for non-contamination of GR-S latex rubber

Homestead lubricated plug valves handling latex rubber.

Through the round ports of Homestead Lubricated Plug Valves at Goodyear Tire and Rubber Company's synthetic rubber plant in Houston, Texas, flow dilute solutions of GR-S latex rubber at 80 p.s.i. and 100° F.

Fluid solutions never lodge and build up in the line since Homestead Round Port Valves provide full circular opening through plug and body of the valve—same size as the pipe they serve.

Controlled pressurized lubrication plus extremely close tolerances between plug and body assure lubrication of all sealing surfaces without contamination of line fluids.

Write for complete details on low first cost, low maintenance, Homestead Valves in our catalog 39-1.

☐ Please send me catalog and prices on Homestead Lubricated Plug Valves. 38

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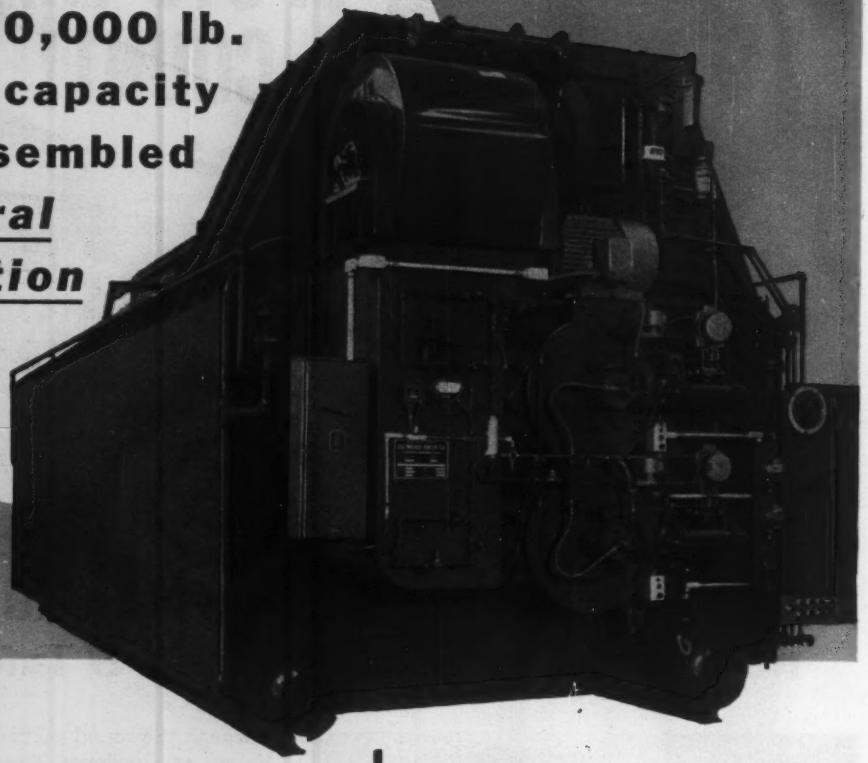
HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. Box 38, Coraopolis, Pennsylvania

...now from WICKES

a new 100,000 lb. per hour capacity shop-assembled *natural circulation* boiler



Wickes Type A units are of simple design, ruggedly constructed and adaptable to a variety of operating conditions and may be fired with oil, gas or combination of both.

All units are shipped completely shop-assembled including superheater, fuel burning equipment, safety and combustion controls, forced draft fan and drive, soot blowers and feedwater regulator.

Save on

- First Cost
- Operating Expense
- Space
- Delivery Time
- Installation Time

For more detailed information on Wickes Type-A steam boilers, write for our catalog 56-1. Bulletin 55-1 covers the complete line of Wickes Products and Facilities.

WICKES type A

WICKES

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DIVISION OF THE WICKES CORPORATION

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169

MECHANICAL ENGINEERING

VOLUME 82 • NUMBER 2 • FEBRUARY, 1960

International Co-operation

Just before he took off on his eleven-nation peace mission on Dec. 3, 1959, President Eisenhower said, "In every country I hope to make widely known America's deepest desire—a world in which all nations may prosper in freedom, justice, and peace, unmolested and unafraid." He carried his message well: Newspaper, news magazine, radio, and TV accounts have attested to this. He has enhanced tremendously both his personal prestige and that of the United States.

And just a few hours before President Eisenhower's departure, ASME's new President, Walker Cisler, delivering the Roy V. Wright Lecture at the 1959 Annual Meeting, proposed that more engineers give some of their time and energy to the problems of the lesser developed nations and also assist in the development of mutual goals in technical matters among nations that share our opportunities for leadership in the application of technology to the basic causes of human want, insecurity, and unrest around the world.

"If those of us who are in a position to help develop understanding and productive relationships between nations fail to do this," President Cisler warned, "I can see little hope for maintaining peace and stability in this uneasy world."

President Cisler's Wright Lecture appears in this issue of MECHANICAL ENGINEERING, and members of ASME—in fact, all engineers—are urged to read it and take heed of his thoughts on international co-operation and assistance.

Besides contributing to peace and understanding, the role of the engineer in international affairs also would go a long way toward increasing both the prestige of the engineer and the technical prowess of the United States.

A Giant Step

The November, 1959, editorial in MECHANICAL ENGINEERING announced that a new publication, *Engineer*, was to be issued periodically by Engineers Joint Council. This newsletter was offered free on request to members of EJC societies. As a result, hundreds of letters from ASME members poured into EJC requesting free subscriptions. At the same time, the possibility of circulating a separate newsletter to all members of EJC societies was seriously under consideration. Recently, EJC took a giant step and acted on such a proposal. Its Board of Directors approved funds to expand distribution of the *Engineer*.

So, for the information of each of the 300,000 engineers who belong to the 21 engineering societies which make up Engineers Joint Council, EJC is rapidly developing a single, common periodical. During 1960, this periodical will be published quarterly; more frequently thereafter. First issues will run to a few pages. This is the simple result of a small budget. As members demonstrate their interest (by so writing to the secretaries of their societies) and as more revenue becomes available, this new periodical will provide more and more useful information to the engineering profession. It will report on EJC activities and other joint society affairs, as well as national news of interest to engineers. (MECHANICAL ENGINEERING for January, 1960, pp. 25 and 26, published —on an experimental basis—a condensed version of the newsletter, *Engineer*, so that all ASME members would have an opportunity to see it. Comments on this method of publication would be appreciated.)

Henceforth *Engineer* will automatically reach the 300,000 members of EJC's component societies. To the hundreds of ASME members who requested subscriptions to *Engineer:* Thanks for the heart-warming interest. And to Engineers Joint Council: Congratulations on taking a giant step toward maintaining personal contact with engineers at the grass-roots level.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.

THE ROY V. WRIGHT LECTURE

established in 1949 in honor of Roy V. Wright, President of the ASME in 1931, is a tribute to his leadership of the engineering profession in political awareness and participation. He urged engineers to serve their country in every way, emphasizing service through public life.

Wherever he goes, the American engineer works with
There may be language barriers, but he finds the
the same the world over. Will he appreciate the

By Walker L. Cisler,

THE ENGINEER IN

I AM deeply appreciative of the opportunity to speak to fellow engineers on this occasion, which is dedicated to the memory of Doctor Royden Vincent Wright, the distinguished engineer and public servant who, during his busy career, was a Fellow, President, and Honorary Member of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

It is with good reason that we are inspired by his lifework because he was outstanding in his accomplishments and yet happily representative of the potential to serve mankind that is in all engineers.

At the time of his passing in 1948, an important characteristic of his wonderful personality was summarized in these words:

"There existed in him a capacity for enlarging the horizons of the areas in which his work lay, for assessing the significance of engineering in terms of social value and public service, in terms of his interest in men as individuals."

It is according to this theme, expressed so well in the life of an engineer whom we all revere, that I wish to explore with you the role of the engineer of today in international affairs.

Engineers in the United States are among the most experienced in the world. After graduation from our excellent schools of engineering, they can find employment in the widest variety of enterprises that any country has to offer. As they progress they gain experience and new opportunities for professional development because of the great amount of investment money that goes continually into research and development, into new enterprises, and into the expansion of progressive and well-established American industries. Their horizons broaden and expand.

Living and working in a nation that guarantees individual freedom of initiative and that encourages social mobility, the engineer can aim as high as he desires, with a very reasonable assurance that he can become as effective an engineer, administrator, and citizen as his abilities and capacity for hard work may lead him.

He also enjoys the technical resources of colleagues in the other industrialized nations who are making parallel progress in fields that coincide with his own endeavors or that are related to them. High-speed transportation, communication, professional associations, technical journals, and international conferences give him ready access to a wealth of information and personal contacts.

This paper, the Roy V. Wright Lecture, was delivered at the Members and Students Luncheon of the Annual Meeting, Atlantic City, N. J., November 30–December 4, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The American Engineer

He has the exhilaration of knowing that he is an engineer in a leading industrial nation in an age of unprecedented technological progress when new achievements are being announced almost daily. All of this, and more besides, make up the good fortune of the American engineer at the beginning of the sixth decade of the Twentieth Century.

Nevertheless, if he pauses for a moment and thinks about the world situation, he realizes that the over-all economic and technological affairs of mankind are seriously out of balance.

Only about one fifth of the more than two and a half billion people in the world enjoy the advantages of advanced industrial development. More than half of all people have hardly the bare necessities of food, clothing, and shelter. Countless thousands who might make important intellectual contributions, if they were adequately trained, will never have that opportunity. Millions keep themselves alive by doing work that is tragically unproductive by our standards of production.

The engineer finds that there are serious imbalances in the distribution of population, fertile soil, water, minerals, fuels, foodstuffs, investment capital, electric energy, and industrial facilities. An equally serious imbalance is the uneven distribution of teachers, scientists, engineers, and technicians.

In other words, although we and the other highly industrialized nations can use vast amounts of energy and raw materials to support relatively high standards of living that permit the favorable development of the individual, there are extensive regions where human and material resources are still largely undeveloped.

These imbalances have resulted in tremendous and dangerous pressures that show themselves in national unrest and disturb the social, political, and economic relationships of all nations.

Money alone cannot do the job that must be done to correct the imbalances that threaten civilization. Governments and diplomats alone cannot solve these problems and remove the many threats to world security. This is a matter that involves all the people in the world —and it must be solved, I believe, with the assistance of people in every nation working together.

If those of us who are in a position to help to develop understanding and productive relationships between nations fail to do this, then I can see little hope for maintaining peace and stability in this uneasy world.

Over the years, it has been my good fortune to work with men in many nations, both as a matter of personal endeavor and on governmental assignments. I have

materials, people, and money.
essential language of the engineer
dignity of other cultures?

President ASME; President, The Detroit Edison Company

INTERNATIONAL AFFAIRS

been deeply impressed to find how willingly these people co-operate with us when they understand the real spirit in which we offer our assistance. I have been particularly impressed by how well the experienced engineer is qualified to get to the heart of this matter of assisting other nations with their problems of economic development.

I would, therefore, propose urgently that we should make it possible for more engineers to give some of their time and energy to the problems of the lesser developed nations and also to assist in the development of mutual goals in technical matters among nations that share our opportunities for leadership in the application of technology to the basic causes of human want, insecurity, and unrest around the world.

Replacement for War

Men must now decide whether they are going to fight each other or close their ranks in a major unified assault against these difficult environmental problems. Not one of them is insurmountable, given the skilled personnel, the capital, and the materials for the work at hand. Where we lack materials, science can very likely find us substitutes. Where we lack conventional fuels, we now have recourse to the tremendous energy resources of fissionable atoms. In turn, the experience of the engineer can be called upon to work near miracles of production. Such an enormous and useful a task should be an excellent replacement for war.

There are heartening signs that engineers are turning their thoughts toward international endeavors. I have worked with the engineers of many nations and have met many engineers from the United States and elsewhere who were at work in areas that needed their broad experience.

These engineers were there because they were able to apply the experience gained at home to the very similar problems in other nations. For example, the Swiss have been most successful in developing hydroelectric resources and in establishing a pattern of industrial and economic activity to offset their extreme lack of fuels and raw materials. Two years ago when I visited the Belgian Congo, the "Darkest Africa" of Stanley, I found a Swiss engineer at Inga on the Congo River, making a study of what is probably the world's largest undeveloped hydraulic site. Belgian engineers and others were giving serious study to the utilization of such power for the production of materials that would represent a further upgrading, by use of energy, of minerals and synthetic fuels for land, sea, and space.

We know that the Union of Soviet Socialist Republics is well aware of the important role that the engineer can play in helping the less developed areas. Russian engineers are already assisting other nations, many of which are not committed at this time to the Soviet system of government.

You may wonder how the American engineer can find the time to lend assistance in other parts of the world. The problem—and it is a problem—is complicated by the fact that the more experienced he is, the more his responsibilities may keep him occupied at home. However, with the use of modern transportation and communication, an engineer who is accustomed to working long and uncertain hours can accomplish a great deal in another part of the world and can return to his regular duties in less time than he would devote to a routine vacation.

Man Should Be Available

I believe that, from the point of view of the employer, the time is well spent because of the need for such international endeavors, as well as for the experience that he brings back with him. A well-balanced company is naturally constituted in such a way that men of wide experience and important responsibility can and should be available to others who need their counsel, whether in the United States or elsewhere for constructive purposes.

There are no serious problems of adjustment for the right man. Wherever he goes, he works with materials, people, and money. Although there may be language barriers, these are no great hindrance because the essential language of the engineer is the same the world over. He always works with much the same tools and materials, according to the same engineering principles and mathematical concepts.

Nevertheless, it is of the greatest importance for him to have the right kind of personality. The best of technicians would be unequal to the task if he were unable to understand and to get along with people. He must have an empathy for the feelings of others that can take into account the dignity of other cultures and the nuances of other manners.

He must be able to implant his skills and experience in a friendly way, feeling genuinely the utmost consideration for the intelligent people whom he will meet, and who are as sensitive as they are delightful. He will learn much from them in return and establish friendships based upon mutual accomplishment. He should help them to plan and to build for themselves, never taking over completely and doing it for them, but helping them to help themselves. In a word, he will be most effective when he acts as a catalyst and a friend.

The Engineer in International Affairs

Statesmen With Slide Rules

When he does this successfully, he becomes an "ambassador" of good will among countries and performs his engineering function in a statesmanlike manner. It follows from all this that he must be able to work without partisan bias, simply and directly as an engineer and humanist. It is not his task to change people but to understand them and to work with them, giving them equal opportunities to understand and to work with him. It was in this spirit that Herbert Hoover rendered such great assistance overseas after World War I and in other periods. And it was in this spirit that John Hays Hammond accomplished so much in South Africa.

A very important corollary to this form of international co-operation is the hospitable reception of engineers and other distinguished visitors from abroad. At The Detroit Edison Company we have received hundreds of groups from other nations, mostly engineers who wish to visit our facilities, study our engineering, financial, and personnel practices. We arrange the details of their visits with the utmost care and regard for their needs.

For the past several years I have had a small part in helping our Department of State in the exchange of people between the USSR and the USA, and I have been called upon on several occasions to arrange for the hospitable reception of Soviet citizens in Detroit. I have responded with the full knowledge that this was in keeping with the policy of our national administration.

As a part of this program, I have made two extensive visits to the Soviet Union with groups from the electric power industry, and each time we were courteously received. We found that the engineers and managers of the Soviet electric power projects were very helpful, answering our questions fully. And we gave them information about our industry as well, so that the exchange might be mutual. We were taken into areas of the country where our own diplomats had not been permitted to travel—and I think we had this freedom because we came as private citizens and had shown a willingness to meet them on a common basis.

When we returned to Moscow after our tour last summer, which had taken us far into Siberia and shown us many outstanding achievements, I was invited to the Kremlin where I had separate visits with Deputy Ministers Anastas Mikoyan and Frol Kozlov, who expressed their appreciation for the hospitality that I, among many others, had shown them on their visits to the United States and Detroit. And it was clear that their visits had had an important bearing upon the plans that had just been announced for an exchange of visits between President Eisenhower and Chairman Khrushchev.

Conversations in Moscow

I said to Minister Kozlov, "We are both engineers and we know something about the tremendous forces of energy that can be used today for constructive or destructive purposes."

And he replied, "Yes, I know, and we must do something about it. We must find the way to keep these great forces from being used for destruction. There is so much that can be accomplished if we will only build and produce in peace."

We discussed rather seriously how we might go about building an electric power plant combining the best of American and Soviet engineering, and to locate this in an underdeveloped country, greatly in need of electric energy, such as India.

I am sure that there was sincerity in what we had to say on the matters we discussed, and that they realize too the importance of peace to the great work needed in their own country to improve housing, roads, and many other things. Both Ministers Mikoyan and Kozlov said they hoped that those of us who had gained a first-hand understanding of the Soviet Union would continue to take part in the building of better relations between our nations.

Since that time, a group of electric power people from the Soviet Union has returned our visit. They saw much of the electric power industry in the United States and spent several fruitful days with us in Detroit. And a few weeks ago a group of Russian nuclear scientists, headed by Professor Vasily Emelyanov, Director of the Main Administration for the Peaceful Uses of Atomic Energy in the USSR, visited our country at the invitation of the United States Atomic Energy Commission. Accompanied by the Honorable John A. McCone, Chairman of the U. S. Atomic Energy Commission, their tour included the Enrico Fermi Atomic Power Plant being built near Detroit. I believe that such visits will contribute importantly to the mutual understanding of scientific and technical problems.

While Chairman Khrushchev was in the United States, I met him briefly in Washington and had some discussion with him regarding the exchange of which I had been a part. He, too, expressed the feeling that this should continue and invited me to make a third visit.

Two-Way Communication

I hope that I have expressed to you some of the reasons why I feel that it is most important for engineers to participate in the many opportunities that we have today for international co-operation in the endeavor to help the lesser-developed nations and to improve the two-way communication with nations, regardless of ideological differences. Acting on the technical level, as private citizens, engineers can do much to acquaint great numbers of the men and women of other nations with our genuine desire and willingness to engage in mutual endeavors that are peaceful and constructive. Many misgivings about our nation can be so corrected.

It is my deep conviction that, as more individuals around the world join us in better understanding and the accomplishment of useful projects, the undercurrent of peaceful motives in the people themselves will be felt by the governments, and an evolution toward better official relationships will begin to take place. It is with this trust in the ability of the people of the world to see the need for co-operation in applying the great technology and energy and material resources of the present day to urgent needs that I look toward the future with great hope and with the prayer that I may continue in a small way to do my part with you as fellow engineers, to make a better life for people in many lands.

By R. G. Jobe, Shell Chemical Corporation, Houston, Texas

A standardized design for a large chemical plant—one size pump meeting requirements for 80 per cent of all the plant's centrifugal pumps

Fig. 1 The new standard pump, shown mounted directly in a piping run without a concrete foundation. The pump case is designed to withstand piping stresses.

PUMP STANDARDIZATION ...A USER'S CONCEPT

SINCE the centrifugal pump is one of the widely used items of equipment in the chemical industry, considerable incentive exists for standardizing this equipment and, in fact, an industry-wide standardization program is in progress. In considering the adoption of a standard pump for our plant, we made a plant-wide study covering approximately 650 centrifugal-pump installations to determine the range of head and capacity requirements, and to obtain cost data to serve as the basis for selecting the optimum standard design.

To establish the range of head and capacity required, the design points for all existing pumps were plotted on one head-capacity chart for comparison. Analysis of the distribution of these points led to the conclusion that the standard pump should be capable of developing a shut-off head of at least 200 ft and a differential head of 120 ft at a capacity of 250 gpm. A pump meeting these requirements would handle approximately 80 per cent of the centrifugal-pump applications in our plant. In order to have a compact pump practical for lower-capacity applications, it was decided that performance beyond these limits should be handled by a larger pump.

Economic Requirements

The basic economic consideration was the lowest overall cost for the life of the pump. We were seeking a unit which would provide an economic balance between the first cost of purchase and installation and the continuing cost of operation and maintenance.

Comparison of continuing costs with capital cost showed that, on the average, during the life of the pump the sum of the continuing costs (maintenance, power, oil, etc.) would exceed the capital cost by several hundred per cent. This indicated that the standard design should emphasize reduction of the continuing costs. This does not mean that capital costs were to be disregarded, but rather that maintenance cost-reduction features would be favored where compromises would be required.

Further analysis showed that maintenance costs were among the most important factors contributing to the continuing costs. It was apparent that maintenance-cost reduction should be one of the primary objectives. Further study led us to conclude that (*a*) the standard pump should be designed so that it could be quickly removed from service for shop repairs; that (*b*) the pump should be simple to dismantle and reassemble in the shop; and that (*c*) the pump should be designed to use a minimum number of component parts.

Because of the relatively small size of our pumps and the unfavorable conditions in the field, it is our practice to make repairs in the shop; hence the installation and removal steps are an integral part of the maintenance procedure. Ease of dismantling under shop conditions and the reduction in the number of parts are features which would be expected to reduce cost of repair parts and further reduce maintenance labor costs.

All features of the standard pump were expected to be consistent with the basic requirements of dimensional

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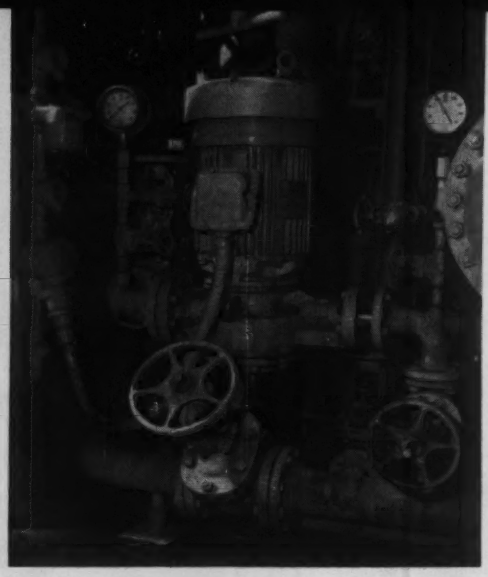


Fig. 2 The standard pump in a congested area, showing the plug-type electric power and grounding connections for quick removal. Driving motors are integral with the pumps.

PUMP STANDARDIZATION
...A USER'S CONCEPT

interchangeability, reliability, and moderate first cost.

Evaluation of the over-all economics and performance requirements resulted in establishing the following criteria:

1 The pump should be capable of providing sufficient capacity to meet the performance requirements for at least 80 per cent of the centrifugal pumps in the plant.
2 It must feature maximum dimensional interchangeability both in mounting dimensions and pump parts.
3 It must be simple to remove and install.
4 It should use a minimum number of parts.
5 It must be simple to dismantle and repair under shop conditions.
6 The installed cost should be as low as possible, consistent with maintenance requirements and reliability.

The implications of these requirements were discussed in detail with the engineers from United Centrifugal Pumps. It was the consensus that existing conventional pump designs did not meet these requirements, and it was agreed that a new pump would be developed as the joint effort of United Centrifugal Pumps and Shell Chemical Corporation.

The New Pump

The pump which evolved is shown in Fig. 1. Basically, it is a vertical centrifugal pump with an integral electric drive. The pump case is designed to withstand piping stresses so that the pump may be installed without a base-plate or concrete foundation.

Fig. 2 shows another of the standard pumps installed in a congested process area. Here again, the pump is supported by the piping and no foundation is used. Since the drivers are integral with the pumps, we have equipped all of the standard units with a plug-type electric power and grounding connection to facilitate quick removal. A safety interlock is provided to turn off the power in case the plug is removed when the circuit is "hot." All motors use 3-phase electric power and are connected in the shop so as to have a standard phase rotation. All outlets are corrected to this phasing as they are installed, so that replacement pumps will always rotate in proper direction without the need for field checks.

The plug-type connection, the vertical design, and the heavy duty case are all features incorporated to meet the requirement for quick removal and installation.

The seven major parts of the pump are shown in the sectional drawing, Fig. 3. These are the case, the cover, the impeller, the shaft, the mechanical seal, the sleeve, and the orifice. A common shaft is used for both pump and motor. The shaft is protected from the process fluid by the impeller, the impeller nut, and the sleeve. This protection permits interchangeability of drivers between alloy and carbon-steel pumps.

Because of the extended shaft, these drivers are not interchangeable with standard vertical motors; however, the cost is comparable to that of horizontal motors of the same classification. Since the pump was designed for use under shop repair procedures, the advantages of close-coupled design could be realized without increasing maintenance costs due to limited accessibility.

The close-coupled design results in reducing the number of parts and improves ease of dismantling by eliminating the pump bearing, the bearing bracket, the lubricator, the shaft coupling, and the coupling guard, all of which are found on the conventional horizontal chemical plant pump. In addition, the integral design results in a more rigid shaft than would be possible for a coupled shaft design of the same diameter. This permits the use of a smaller mechanical seal.

Since alloy construction is sometimes required for pumps in chemical plant service, this pump was designed for ease of casting so that it could be economically built in any castable alloy. The shaft is fully protected by the wetted parts so that special motors with alloy shafts will not be required for alloy pumps.

Performance

The pump uses a plug-type discharge orifice to modify the performance of the basic unit. The orifice serves to eliminate the need for providing oversize drivers for lower-capacity applications and to modify the head-capacity relationship at lower flow rates. Its effect is illustrated by the curves in Fig. 4. The upper curve represents the maximum available head. For full protection to the end of the curve, a 25-hp driver would be required. A 1-in. diam orifice limits the power requirements to 20 hp, and a $^3/_4$-in. diam orifice will limit the power requirement to 15 hp.

For smaller impeller diameters the power requirements can be limited to 3 hp. As with other centrifugal pumps, the efficiency drops off at lower flow rates. Low-rate efficiencies can be improved through the selection of appropriate impeller patterns. Since our electric power costs are relatively low (0.7¢/kwhr) we have been able economically to standardize upon one impeller pattern to minimize the number of different spare parts.

The effect of impeller diam and orifice bore upon head and capacity performance is shown in Fig. 5. The pump is not limited to the curves shown. Intermediate impeller diameters or orifice bores may be used. Any performance point within the maximum capabilities can be approached by trimming the impeller, by reducing the orifice diameter, or by a combination of both methods. The particular combination selected depends on whether the objective is (*a*) to limit maximum power requirement, (*b*) to obtain a particular slope of head-capacity curve, or (*c*) to obtain maximum efficiency.

Table 1 Plant Service Tests for Standardized Pumps

Service	Duty	Temperature
Intermediate process, fluid containing resin particles	Continuous	150 F
Cooling water circulation	Continuous	60 F
Liquid petroleum gas with abrasive particles	Continuous	100 F
Crude alcohol transfer	Intermittent	Ambient
Acetone column bottoms	Continuous	225 F
Cooling water circulation	Continuous	60 F
Liquid petroleum gas	Continuous	100 F
Cooling water circulation	Continuous	60 F
Lower layer from resin phase separator	Continuous	180 F
Epichlorohydrin loading	Intermittent	Ambient
Allyl chloride loading	Intermittent	Ambient

The smaller orifices provide "steeper" head capacity curves which may be desirable for certain applications. Efficiency is higher if a larger orifice bore is used.

The actual pump will provide a maximum differential head of 206 ft at 125 gpm. Maximum capacity is approximately 390 gpm at 135 ft differential head. NPSH requirements vary from 4 ft at 50 gpm to 19 ft at 390 gpm. On this basis, the pump meets the original requirement to cover approximately 80 per cent of our applications.

Initial Tests

The prototype was performance tested at the factory during the latter part of 1957, and was installed in the plant for service tests in January, 1958. Ten additional pumps were installed during the following eight months. For test purposes, a cross section of plant services was selected as shown in Table 1.

Early experience in process services showed that the motor was vulnerable to damage from vapors and liquids which leaked past the pump seal. Before design changes were made, a series of lower-bearing failures was experienced, and in three instances the insulation on the motor windings failed due to chemical attack. The following design changes appear to have eliminated premature motor failures:

1 Ventilation ports were provided in the upper part of the pump case and in the lower part of the motor housing to permit vapors to escape. The case had been enclosed, in the original design, to confine fluid leakage to the drainage ports. However, experience indicated that adequate ventilation of the upper pump case was of primary importance.

2 Teflon sealed bearings were installed in the motor.

3 A drainage port from the back of the stationary seal face was provided as an outlet for fluids leaking past the seal faces.

Although the new design has only recently emerged from the development stage, some indications as to the effect of the design on plant pump costs have resulted from our experience in the field. Comparison of the installed costs for the eleven test units with similar costs for conventional medium duty horizontal centrifugal pumps in these services shows that installed costs (including the price of the pump) were reduced 20 per cent to 35 per cent below that of conventional pumps of cast-steel construction. These savings are due largely to the elimination of concrete foundations and the elimination of the shaft coupling with its alignment problems.

In the congested process areas of existing plants the compact design permits the standard pump to be installed without undue extension of piping or blocking of accessibility to existing equipment. In new construction we believe that further savings especially in piping costs could be made by judicious mounting of pumps on major equipment or on pipeways as is done with motor valves.

The pump has shown no tendency to require undue maintenance. During the six months' period since January 1, 1959, there was only one failure experienced out of 16 pumps in operation. This was a mechanical-seal failure due to the presence of abrasive particles. The pump was reinstalled with a set of tungsten carbide faces and it has been since operating satisfactorily.

Labor requirements to remove and reinstall the new pump are about 25 per cent of that required for our horizontal units. Because they can be quickly removed and installed, we have purchased several complete standard pumps to be kept in stock for use as replacements. We believe that this will reduce the amount of emergency repair work presently required on critical units. Although a service time of only one year has been available to establish comparative maintenance costs, experience to date shows the maintenance cost to be 15 to 25 per cent less than that for comparable horizontal pumps.

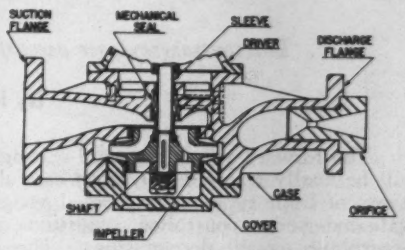


Fig. 3 Major parts of the standardized pump. All similar parts are dimensionally interchangeable between pumps. The shaft is protected from process fluids, permitting interchangeability of driving motors.

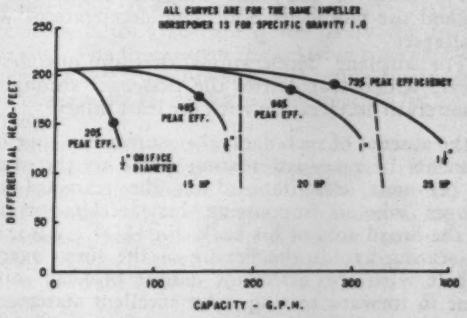


Fig. 4 A plug-type discharge orifice modifies the performance of the basic unit, providing overload protection. These curves are all for the same impeller. Horsepower is for a specific gravity of 1.0.

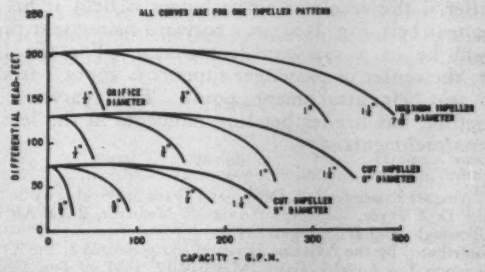


Fig. 5 Showing the combined effect of varying orifice bore and impeller diameter

AIRCRAFT

Fig. 1(a) The nature of the controversy. The extreme flexure of the forward-facing dummy versus the upright position of the rearward dummy.

The controversy over aircraft seating—forward versus rearward—continues. This paper

By I. Irving Pinkel, Chief, Fluid Systems Division, Lewis Research Center,

THE forward versus rearward-seating controversy will be finally resolved only after carefully engineered seats of both types having equal weight have been evaluated under controlled conditions approximating airplane crash decelerations. The relative excellence of the seats would be judged on two cardinal points:

1 For seats of the same weight, which one can withstand the more severe airplane decelerations without collapse?

2 For airplane decelerations that do not destroy the seat, which seat carries the passenger through the airplane crash deceleration with the least injury?

In the absence of such data, the controversy continues. Proponents of rearward seating point to the smaller load per unit area imposed on the rearward-facing passenger who is supporting his deceleration force with the broad area of his back, Fig. 1(*a*). Also, rearward seating avoids the flexing of the torso over the seat belt with the attendant danger of head injuries present in forward seating. An excellent statement of the case presented by the proponents of rearward seating is given by Fryer.[1]

Proponents of forward-facing seating hold that the forces on the seat floor attachments and seat legs are smaller if the decelerating passenger is held at his hips by a seat belt, Fig. 1(*b*), in a forward-facing seat than it would be in a rearward-facing seat. For the latter seat, the center of passenger support is about 1 ft above the seat-belt attachment point. The rearward seat, therefore, has higher bending moments in the legs and floor attachments.

[1] "Aircraft Passenger-Seat Design and Crash Survival," by Squadron Leader D. I. Fryer, Institute of Aviation Medicine, Royal Air Force, Farnborough, England, August, 1958.

Contributed by the Aviation Division and presented at the Aviation Conference, Los Angeles, Calif., March 9–12, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 59—Av-28.

Engineering Analysis

While the final answer requires a test of the actual seats, engineering analysis can show some of the inherent advantages one seat type may have over the other.

The method employed for the computation of seat tolerance to airplane deceleration is an extension of the method given by Pinkel and Rosenberg.[2]

The deceleration of the airplane floor, to which the seat is attached, has one or two brief periods in a crash during which the deceleration reaches values high enough to endanger the seat. A time history of these peak deceleration periods shows that they are composed of a primary deceleration pulse on which one or more secondary pulses of shorter duration are superimposed (Fig. 2).

A review of crash-deceleration records taken during the NASA crash research program shows that the frequency (f_a) for the primary deceleration pulse usually ranges from 0.7 to 6.0 cycles per second (cps), corresponding to a duration ranging from 0.7 to 0.08 sec. Secondary pulses of sufficient time duration to stress the airplane seat last for about 0.04 sec. This duration corresponds to a sine wave frequency of 12.5 cps.

While there is no necessary relationship existing between the relative magnitude of the primary and secondary pulses, a review of the crash-deceleration records shows that the secondary pulse usually accounts for 40 per cent of the total magnitude of the peak airplane deceleration A_a.

The seat constitutes a flexible link between the passenger and the airplane floor. The deceleration force on the passenger is applied by the seat. This force at any instant is equal to the product of mass of the passenger and his deceleration. Seat collapse is threatened when the passenger deceleration peaks.

In this comparative study it is assumed that the same seat material and design ingenuity are available to the designers of the forward and rearward-facing seat.

[2] I. Irving Pinkel and Edmund G. Rosenberg, "Seat Design for Crash Worthiness," NACA Rep. 1332, 1957.

SEATING-

Fig. 1(b) This test was made during the NASA crash-research program. Apparent safety of the rearward-facing dummy may be illusory.

presents a method for determining when to trade the benefits of one seat type for another.

National Aeronautics and Space Administration, Cleveland, Ohio.

The seats to be compared are to have the same weight. The often-repeated assertion of the proponents of rearward seating that a modest increase in weight would make the rearward-facing seat as strong as forward-facing seats is unacceptable in this comparison. The same weight increase applied to the forward-facing seat would increase its strength as well.

The Basic System

Basically, an airplane seat is a vertical cantilever beam, fixed at its lower end, which supports a passenger somewhere along its length. For a 6-ft, 200-lb passenger, the point of support is taken as 1 ft above the floor for a forward-facing seat and 2 ft for a rearward.

Three forward-facing seats, having a design strength F_d of 2000, 4000, and 6000 lb, were chosen for this study. With a 200-lb passenger, these seats are said to have a strength of 10, 20, and 30 g, respectively. Because F_d is the steady force applied at the point of passenger support required to stress the seat to the elastic limit, rather than to the collapse point, this definition of seat strength is at variance with common usage.

Since the passenger-restraining force in the rearward-facing seat is applied at twice the distance from the floor, the rearward-facing seats having the same weight as these forward-facing seats have a design strength, F_d, of 1000, 2000, and 3000 lb. In terms of the acceleration of gravity, these rearward seats would be 5, 10, and 15-g seats, respectively.

In the computations[3] which produced the data in Table 1 and Fig. 3, it was assumed that the response of the passenger-seat system to the secondary deceleration pulse can be added to its response to the primary pulse. It was assumed further that the secondary pulse is so timed with respect to the primary pulse that the passenger deceleration in response to both pulses attains peak values at the same moment.

[3] Copies of the complete paper, No. 59—Av-28, can be obtained from the ASME Order Department, 29 West 39 Street, New York 18, N. Y., at 80¢ per copy (40¢ to ASME members).

The data of Figs. 3(*a*), (*b*), and (*c*) show that the difference in tolerance between the forward-facing and corresponding rearward-facing seat of the same weight is less for airplane deceleration frequencies of about 6 cps than for lower frequencies. This is particularly true for the 10-g forward-facing seat and its corresponding 5-g rearward-facing seat.

Data obtained during the NASA crash research program show that airplane-crash deceleration pulses in the range from 2 to 4 cps are quite likely for transport airplanes. For this reason the relative tolerance of the forward and rearward-facing seat must be judged in favor of forward facing by a wide margin for all three seat pairs.

Evidence of this margin in favor of forward seating was obtained in one of the NASA crash studies in which two ancient 6-g double seats, with dummies, were carried through a 10-g 0.32-sec crash pulse. One of the double seats faced rearward, the other forward. The rearward seats collapsed completely, while the "passengers" in forward seats were still in place.

Passenger Injury

Since the principal concern is for the welfare of the passenger, it is required to examine the matter of passenger injury in seats that do not fail. A proper study of this matter would provide a basis for determining when it is profitable to trade a margin of seat tolerance to airplane deceleration for better passenger protection in

Table 1

Seat type	Total weight, W_T, lb	Design strength F_d, lb	Design strength A_d, g	Natural frequency, f_n, cps	Design flexure, X_d, in.	Seat deformation energy, E_s, ft-lb
Forward	32	2000	10	7.0	2	670
Rearward	32	1000	5	2.5	8	1330
Forward	41	4000	20	11.7	1.6	1070
Rearward	41	2000	10	4.2	6	2000
Forward	49	6000	30	16.0	1.3	1300
Rearward	49	3000	15	5.7	4.6	2300

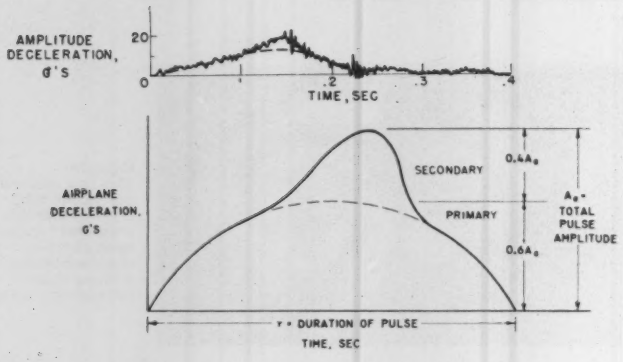


Fig. 2 Crash deceleration pulse. The idealized form, **bottom**, and the actual deceleration record, **top**. From NASA studies.

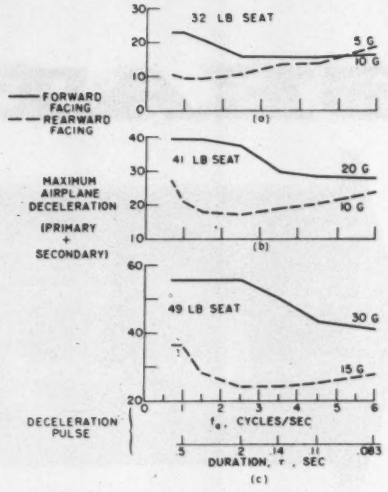


Fig. 3 Three different seats, and the deceleration they can sustain

the seat. While useful data have been obtained on human tolerance to deceleration alone, notably by Col. J. P. Stapp, the paucity of tolerance data, when body blows to the seat or passenger flexure over the seat belt are also involved, makes such a determination difficult. This section of the paper is devoted therefore to a review of a suggested method for determining under what conditions seat tolerance to airplane deceleration might be sacrificed for better passenger protection in the seat. Any method devised at this time is, at best, only a crude criterion for making such a determination.

As a first step in establishing the proposed method, assume that it is possible to predict the most probable relation between airplane deceleration pulse duration τ and pulse amplitude A_o. A review of deceleration pulse data obtained in the NASA crash research program indicates that this relation has the form shown in Fig. 4. The larger the peak airplane deceleration, the shorter the duration of the pulse.

The data of Figs. 3(*a*), (*b*), and (*c*) provide the combinations of deceleration pulse magnitude and duration that produce seat collapse. The points at which seat collapse would occur are indicated on the curve of Fig. 4 for the three forward and rearward seats.

As a second step in the proposed method, assume that injury data are available on human subjects or suitable substitutes that permit a plot of passenger injury as a function of airplane-deceleration pulse duration and magnitude. Pulse duration and magnitude are to be related in the manner shown in Fig. 4.

It is suggested that the plot may have the form shown in Fig. 5. The curve for rearward facing is based in part on known human tolerance. The curves for forward seating are only the author's impression of what they might be for the majority of airline passengers. Delethalized seat-back structure is assumed.

The curves of Fig. 5 imply a considerable margin of protection from injury for the rearward-facing seat over the forward-facing seat. Assuming this margin to be a fact, one applies these curves in the following way to judge when the injury protection of rearward-facing seats may outweigh the greater crash deceleration tolerance of the forward-facing seat of the same weight. In applying this method, two crash conditons are recognized: High likelihood of fire or ditching emergency following crash, and crash on land with aircraft which have a low probability of catching fire.

Down to Cases

For the first case where fire or ditching emergency follows crash, those who suffer disabling injuries in the crash deceleration have a much reduced chance of escape and are apt to be lost. According to the hypothetical curves of Fig. 5, this condition occurs at a crash deceleration amplitude and duration of 17 g and 0.26 sec, respectively, for the forward-facing seat with a clear swing for the torso. Reference to Fig. 4 shows that this injury level occurs after a 32-lb (10-g) forward-facing seat would have failed. Setting such a seat rearward would produce no useful gain.

However, if a 41-lb (20-g) seat were used in the airplane, its rearward facing (10-g) configuration would hold the passenger without severe injury. But it would be stressed to the limit. The advantage of rearward facing would have some meaning in this instance. This advantage is obtained at a large sacrifice in seat tolerance to deceleration, since the forward facing 41-lb seat would hold to 35 g with a deceleration pulse duration of 0.13 sec, Fig. 4.

In aircraft employing high-density forward seating, head strikes on adjacent seat backs become more likely. The hypothetical injury curves, Fig. 5, show disabling injury at a crash pulse deceleration amplitude and duration of 10 g and 0.36 sec. This deceleration pulse is within the capability of the 32-lb (5-g) rearward-facing seat, Fig. 4. Rearward facing would have some meaning in this instance, also. The 32-lb forward-facing seat would hold to 16 g as compared with 13 g for this rearward seat. In view of the high probability that crash-deceleration pulses may lie between 13 and 16 g, this cost in seat tolerance is significant.

For the second case where no post-crash emergency exists, one must allow that a passenger who is held in place by his seat generally fares better than one who breaks free. According to the chart of Fig. 4, the zone of most probable deceleration-pulse magnitude lies

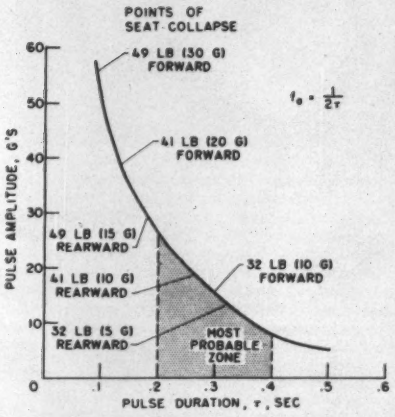


Fig. 4 Points of seat collapse. Values assigned to the ordinate and abscissa are the author's estimate for a large, modern transport involved in a crash during take-off or landing. Estimate based on NASA data.

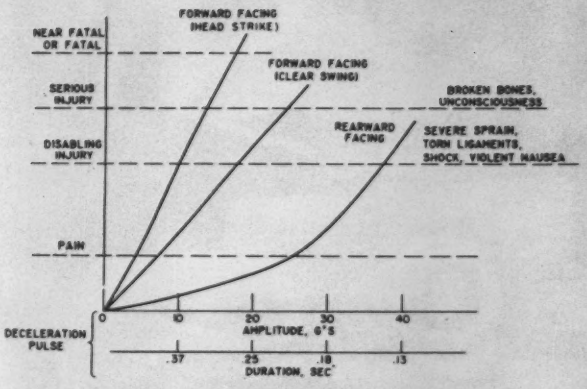


Fig. 5 Hypothetical injury curve. Three cases: Rearward facing, forward facing with space between seats for clear swing of the torso over the seat belt, and forward facing with head strike on the adjacent seat.

between 8 and 25 g. A rearward-facing seat weighing 48 lb would serve this range with very little margin to spare. A forward-facing seat of 41 lb would serve quite well with a considerable safety factor. If a seat weight of 48 lb is considered excessive for airline transports, then no rearward-facing seat would serve for the entire range of probable crash-deceleration pulses.

The high probability of severe or fatal head injuries with high-density forward-facing seats may require a trade of seat tolerance for added injury protection afforded by rearward seating even in the case of no post-crash emergency. The hypothetical injury curve of Fig. 5 shows a near-fatal or fatal head strike would occur in a deceleration pulse of 16 g lasting for 0.25 sec. Such injuries are as serious as those which occur if the seat breaks. If the airplane is to use a 41-lb seat, Fig. 4 shows how its rearward-facing configuration would serve.

Tighten Your Seat Belt

As a concession to simplicity, complicating factors have been avoided in this discussion. Chief among the neglected factors is the matter of slack when the forward-facing passenger wears his seat belt loosely. Flexure of the passenger over his seat belt constitutes slack that is always present in forward-facing seats. This slack can reduce markedly the deceleration-pulse seat tolerance.

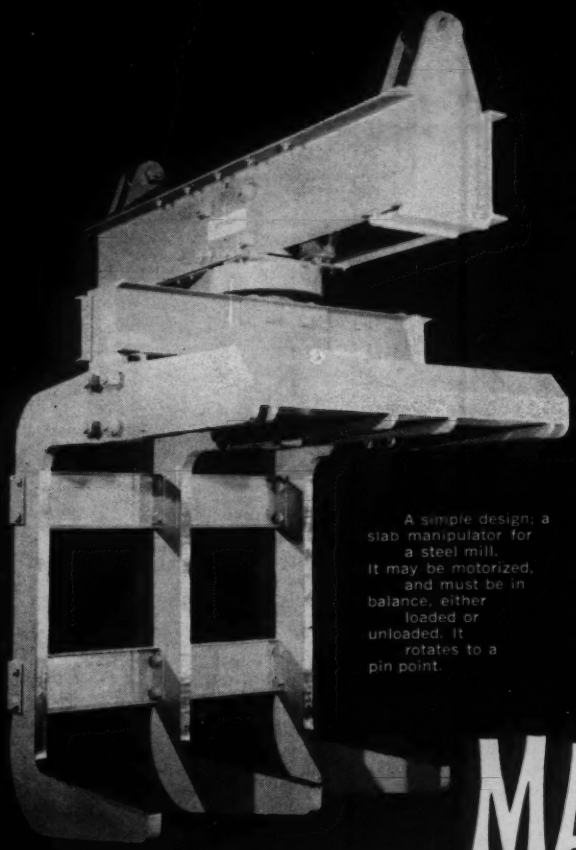
Slack appears in the rearward-facing seat because passengers generally sit with their lower back about 4 in. from the seat back. Also, the rearward-facing passenger is supported away from the substantial structure of the seat back by a layer of padding. The rearward passenger's motion in a crash in compressing this padding constitutes slack. In this sense, comfort features of the seat are often in conflict with crashworthiness. In the matter of slack, the forward-facing seat, with its higher natural frequency of oscillation, is more vulnerable to depreciation of crash-pulse tolerance than the more limber rearward-facing seat. It is difficult to assess the margin of advantage the rearward-facing seat enjoys in this respect without actual trial with the seats as they would be used on the airplane.

Rearward-facing seats expose the passenger to the shower of loose objects in the airplane that fly to the front of the airplane when a crash occurs. If hard objects break free, then the chance for passenger injury is very real. Fig. 6 shows an escape hatch that broke free flying into the face of the rearward-facing passenger.

The best passenger position in anticipation of a crash or ditching would be with chest against thighs in the forward-facing seat. For rearward seated passengers the best position in anticipation of the crash would be upright, with firm seat contact along the entire back.

Proposals have been made to support passengers upright in forward-facing seats and thereby avoid flexure over the seat belt in a crash. These proposals include the use of chest and shoulder straps and a variety of devices for supporting the upper torso from the back of the seat ahead. Any measure that supports the upper torso upright by forces exerted on the passenger's seat or adjacent seats converts the design strength and natural frequency of oscillation of the forward seat to that of the rearward seat. The two seats would now have the same crash-deceleration tolerance.

Fig. 6 Interior of a crashing airplane showing an escape hatch striking a rearward-facing passenger. In a well-managed airplane, the number of such missiles would be small.



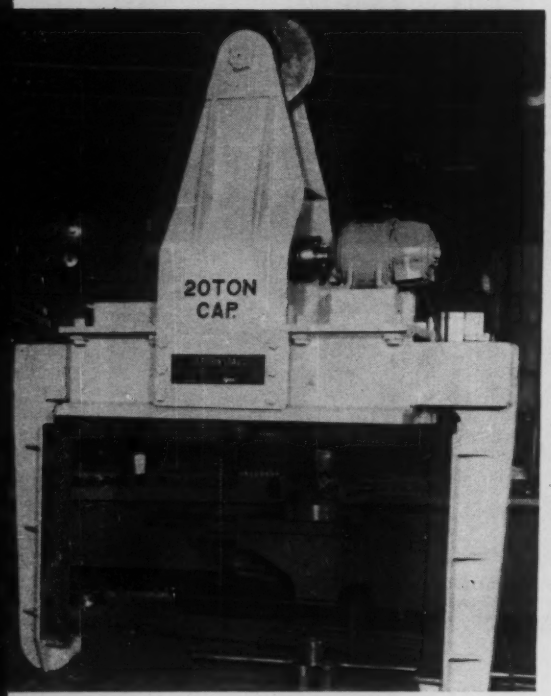
A simple design; a slab manipulator for a steel mill. It may be motorized, and must be in balance, either loaded or unloaded. It rotates to a pin point.

MECHANIZATION makes it imperative that engineers develop special devices for handling difficult objects. Manipulators are designed to do specific jobs such as: Handling objects of great weight or large dimensions; functioning in close quarters; carrying out process operations; feeding material in and out of machine tools; facilitating assemblies; handling loads in high temperatures, and in liquids or abnormal atmospheres. Examples are tongs, grapples, and rotators. In general, the manipulator meets the demand for innovation and invention in handling operations. Illustrated are several types of modern manipulators which make obsolete the conventional methods.

Based on a paper contributed by the Materials Division and presented at the Annual Meeting, Atlantic City, N.J., Nov. 29-Dec. 4, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. ASME Paper No. 59 — A-186.

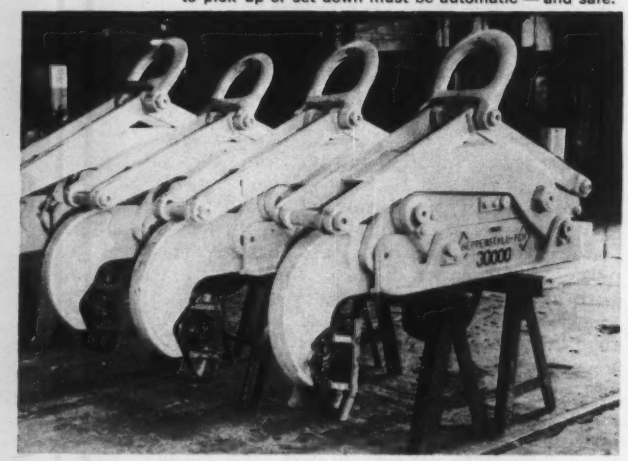
THE MANIPULATOR:

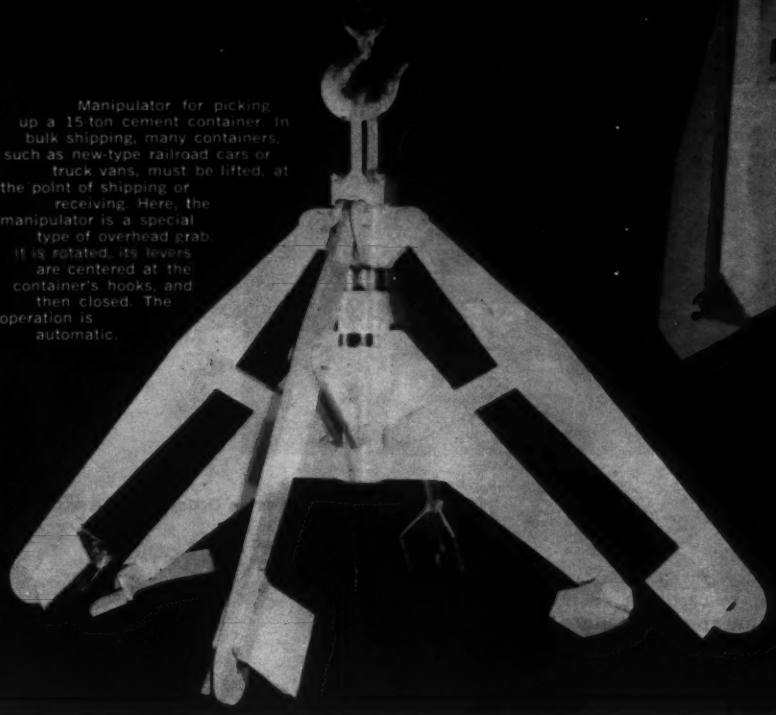
Its Design and Application



A rack-and-pinion motorized tong. Motorized shoes are required to move in or out, or at angles, to grab and pick up the load.

Automatic sheet-coil manipulator. The load will be a 15 to 40-ton coil of steel sheet, of varying inside and outside diameter. The operation to pick up or set down must be automatic — and safe.

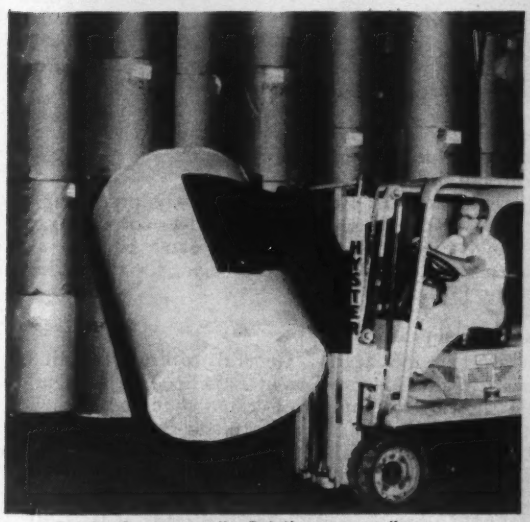




Manipulator for picking up a 15-ton cement container. In bulk shipping, many containers, such as new-type railroad cars or truck vans, must be lifted, at the point of shipping or receiving. Here, the manipulator is a special type of overhead grab. It is rotated, its levers are centered at the container's hooks, and then closed. The operation is automatic.

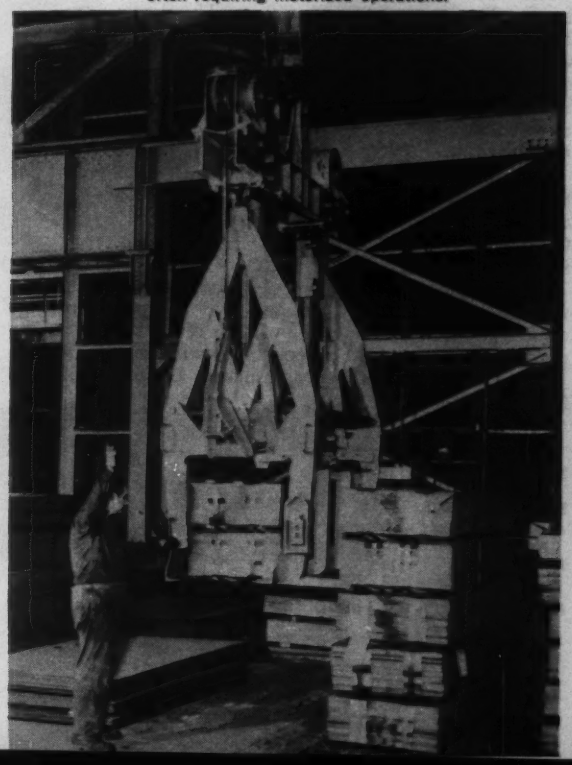
A rotater manipulator where the load must be rotated and set in a predetermined position. Rotators do this for loads of 10 to 200 tons.

By J. C. Somers, Mem. ASME, President, J. C. Somers & Associates, Industrial Engineers, Long Island City, N.Y.



Rotator for paper rolls. Rotating or upending is always a problem, not always as simple as shown here. There will be varying centers of gravity, and problems of positioning.

Motorized sheet lifter. Packaged loads or unit loads call for flexible manipulators, often requiring motorized operations.



ANNUAL REVIEW

PROGRESS IN RAILWAY MECHANICAL ENGINEERING

1958 1959

MOTIVE-POWER developments in the past year have been characterized by a trend toward higher locomotive horsepower. The railroads of the United States have been improving their services by speeding up freight movements. This has been reflected in their purchases of new locomotives. During the year ending June 30, 1959, orders were placed for more than 200 2400-hp units.

The distribution of motive-power types in the United States as of July 1, 1959, is shown in Table 1. The number of diesel units owned or leased increased by 442 units in the past year, while the number of steam locomotives decreased by 735 units.

Locomotive Development Activities

It was announced that the active work of the Locomotive Development Committee of The Bituminous Coal Research Institute would be discontinued, though the Committee would continue to function in an advisory capacity. The coal-burning gas-turbine installation is being moved to Morgantown, W. Va., where it will be used to establish feasibility of the coal-burning gas turbine for stationary power plants [2].[1]

The Association of American Railroads report of research activities for 1958 covers a wide range of subjects of interest to the railroads, and the Research Center at Chicago functioned in 1958 for the first time under the newly created Research Department.

The British Railways modernization program continues, with increases announced in the power ratings of some locomotives being built on repeat orders. The plan is now estimated to cost approximately $5 billion [3]. The status of the program may be summarized as follows [4]:

Number of Locomotives on Order or In Service

Main-line locomotives—800-hp to 3000-hp	586
Switching locomotives—diesel-electric, 350-hp	1229
Switching locomotives—diesel hydraulic or diesel-mechanical, 150 to 500-hp	354
Multiple-unit vehicles	3551

In Russia, in addition to developments mentioned elsewhere in this report, a 3000-hp locomotive with hydraulic transmission is being completed. It will be powered by four 750-hp engines. Also, said to be in the design stage is a 3500-hp locomotive powered by two high-speed engines and using fully sprung motors for speeds up to 100 mph [5].

Another Russian development [24] is an opposed-piston engine of increased rating. It was reported last year [9] that the Russian TE-3 locomotive used a 10-cyl opposed-piston engine of the same bore and stroke as the Fairbanks-Morse engine. The new engine has 12 cyl instead of 10, and uses turbosupercharging followed by cooling before the air enters the cylinders. The specific fuel consumption at full load is stated to be 0.36 lb bhp-hr.

A combination of European builders is producing an order of 50 6000-hp electric locomotives for the Trans-Siberian Railways in Russia. The same builders also have an order for 25 such locomotives for the Chinese Republic [6].

Diesel Locomotives

In the United States, General Motors introduced domestic 6-axle locomotives of 2400 hp, Fig. 1, item 1, Table 2 [7, 8]. A number of design changes were made on the 567 engine to obtain an increase in output from 1750 to 2400 hp. The positive-displacement blower which has always been used with this engine has been

Table 1 Locomotives of Class 1 Railroads of U. S. [1]

	Diesel	Steam	Electric	Gas-turbine	Total
Units owned or leased	28032	1002	550	33	29617
Units stored-serviceable	231	344	49	0	624
Units awaiting repairs	1318	449	86	0	1853

[1] Numbers in brackets designate References at end of paper.

Report of Committee RR-6 Survey: Chairman, D. R. Meier; Members, R. M. Coultas, H. G. McClean, A. G. Dean.

Contributed by the Railroad Division and presented at the Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Paper No. 59—A-264.

NOTE: The survey covers the period September 1, 1958, to September 1, 1959.

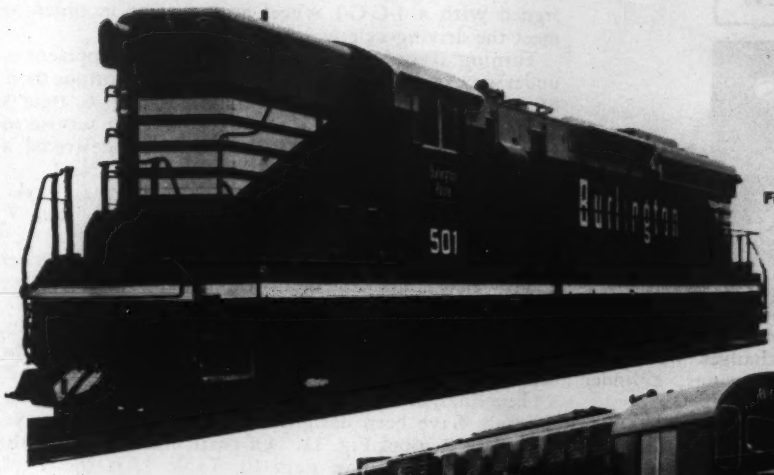


Fig. 1 GM-built 2400-hp locomotive

Fig. 2 2400-hp Alco locomotive for Santa Fe

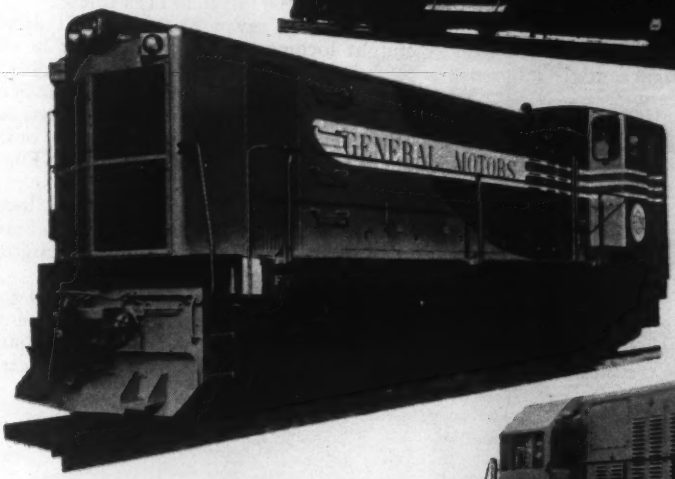


Fig. 3 800-hp lightweight locomotive

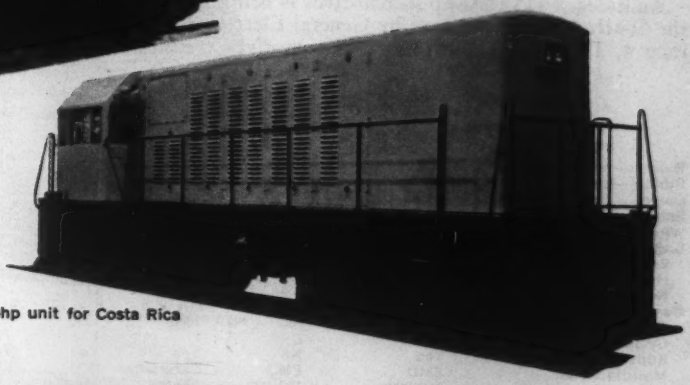


Fig. 4 600-hp unit for Costa Rica

1958 *A review of developments in railroad motive power and rolling stock, both in the United States and abroad* **1959**

replaced with an exhaust-gas-drive supercharger together with intercoolers. An over-running clutch device is arranged so that the blower is positively driven at lower speeds and horsepowers. Design changes were also made on the crankcase, pistons, bearings, cylinder heads, injectors, and so forth.

Three American builders are now offering 2400-hp, 6-axle freight locomotives. Alco introduced such a locomotive in 1955 [9] and Fairbanks-Morse in 1953. A recent development in styling in these large locomotives is the low-height hood for improved visibility, introduced on Alco locomotives for use on the Santa Fe Railway, Fig. 2.

A turbocharged 2000-hp general-purpose locomotive has also been introduced by General Motors. Design improvements have also taken place on the normally aspirated series which comprise the 1800 and 1325-hp locomotives.

A General Motors 800-hp locomotive designed for export is light in weight—107,000 lb—and designed to operate on track gages ranging from 3 ft 0 in. to 5 ft 6 in. Two body-mounted traction motors are mounted longitudinally, each driving both axles of a truck through cardan shafts and gearboxes, Fig. 3, item 2, Table 2.

General Electric has delivered to Costa Rica an order for 600-hp locomotives, Fig. 4, item 3, Table 2. This locomotive represents an addition to the builder's standard export line.

An order of 115 1800-hp locomotives is being built for the South African Railways by General Electric, Fig. 5, item 4, Table 2. These 1800-hp locomotives were designed with a 1-C-C-1 wheel arrangement in order to meet the driving-axle weight limitation.

Turning abroad, varied and significant development is under way as the railroads of many nations continue their dieselization. The 1425-hp locomotive, Fig. 6, item 5 of Table 2, is a German locomotive built for service in Ghana. The same builder, Henschel, has delivered a substantial order to Austria, Fig. 7, item 6, Table 2.

In Australia, Clyde Industries has built a 3-axle, diesel-hydraulic switcher locomotive, Fig. 8, item 7, Table 2 [10].

MAK of Kiel, Germany, has built a 1200-hp switcher for the German Federal Railways, Fig. 9, item 8, Table 2.

Alsthom of France has built two 6-axle, 1400-hp, diesel-electric freight or passenger locomotives for the Colombian National Railways, Fig. 10, item 9, Table 2.

Ten English Electric-built freight or passenger locomotives have been designed for the British Railways' Southern Region, Fig. 11. Of particular interest in the details enumerated in item 10, Table 2, is the 9-cyl, opposed-piston, 1100-hp engine applied to this unit [11].

A number of British manufacturers have collaborated to build a prototype locomotive for the export trade, Fig. 12, [12]. This C-C unit has an axle load of 26,400 lb and has been designed to be available in various gages, ranging from 1 meter to 5 ft 6 in., item 11, Table 2.

One hundred and forty seven 2300-hp 1C-C1 diesel passenger or freight locomotives are being built in the shops of the British Railways, Fig. 13, item 2, Table 2 [13]. The twin-bank engines for the first ten locomotives will be supplied by Sulzer Brothers, Winterthur, Switzerland. Engines for the remainder of the order will be built under license by Vickers-Armstrong (Engineers) Ltd. [25].

Fiat of Italy has built a 1320-hp diesel-electric locomotive, one of 56 units ordered for the the Italian State Railways, Fig. 14, item 13 of Table 2. It was designed for secondary services on nonelectrified lines [14].

The replacement of steam motive power by diesel and electric locomotives has continued at a rapid pace in Russia [5]; 1056 locomotives of both types were built in 1958. Of particular interest is the TE-10 diesel-electric

Table 2 Diesel Locomotives

Item No.	1	2	3	4	5	6	7
Builder—mechanical	EMD	EMD	GE	GE	Henschel-Werke	Henschel-Werke	Maybach and Clyde
Builder—electrical	EMD	EMD	GE	GE	EMD	EMD	
Owner	ATSF, UP, CBQ		Costa Rica	SAR	Ghana	Austria	Commonwealth Rwys.
Service	Freight	G.P.	Switching	P,F	Freight	Mixed traffic	Shunting
Wheel arrangement	C-C	B-B	B-B	1C-C1	C-C	B-B	0-6-0
Engine data:							
Engines per cab	1	1	1	1	1	1	1
Hp rating per engine	2400	800	640	1800	1425	1425	625
Number of cylinders	16	8	12	12	12	12	6
Bore and stroke, in.	8 1/2 × 10	8 1/2 × 10	5 3/4 × 8	9 × 10 1/2	8 1/2 × 10	8 1/2 × 10	7.3 × 7.875
Engine speed, rpm	835	800	1300	1000	835	835	1500
Cycles	2	2	4	4	2	2	4
Supercharging	Yes	No	Yes	Yes	Yes	Yes	Yes
Manufacturer	EMD	EMD	Caterpillar	C-B	EMD	EMD	Maybach
Weight on drivers, lb	318,000	107,000	130,000	168,000	182,980	158,750	118,800
Total locomotive weight, lb	318,000	107,000	130,000	213,000	182,980	158,750	118,800
Fuel capacity, U. S. gal.	1200–3000	525	400	1150	962	528	430
Driving wheel diam, in.	40	33	36	36	43 1/2	41	37
Type of transmission	Electric	Elec-Mech.	Electric	Electric	Electric	Electric	Hydraulic
Track gage, in.	56 1/2	36–66	42	42	42	56 1/2	56 1/2
Maximum speed, mph	65–90	45	59	55	62	62	45
Figure number	1	3	4	5	6	7	8

EMD—Electro-Motive Division of General Motors Corp.
ATSF—The Atchison, Topeka and Santa Fe R. R.
UP—Union Pacific R. R.
CBQ—Chicago, Burlington and Quincy R. R.
SAR—South African Railways
C-B—Cooper-Bessemer Corp.
GE—General Electric Company
G.P.—General Purpose
P—Passenger service
F—Freight service

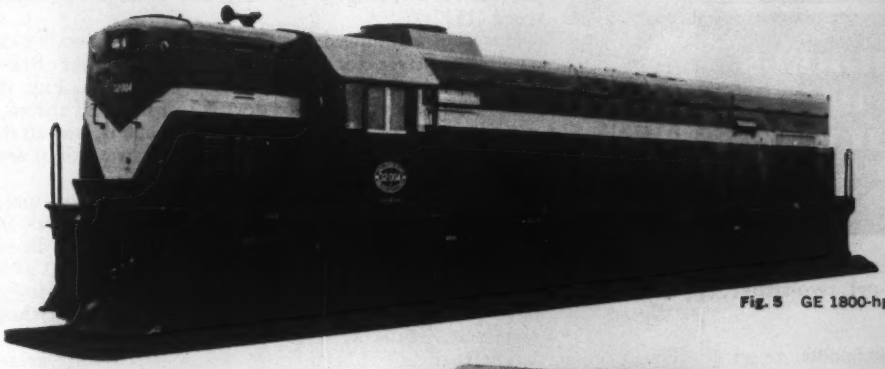


Fig. 5 GE 1800-hp locomotive for South Africa

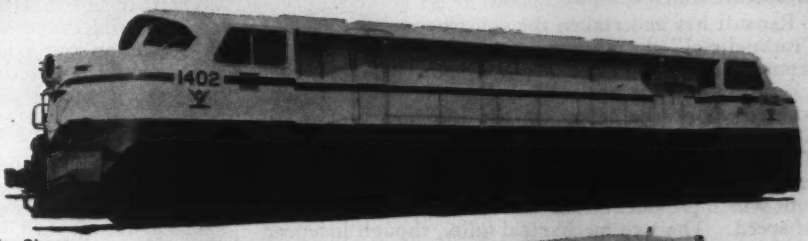


Fig. 6 Henschel built locomotive for Ghana

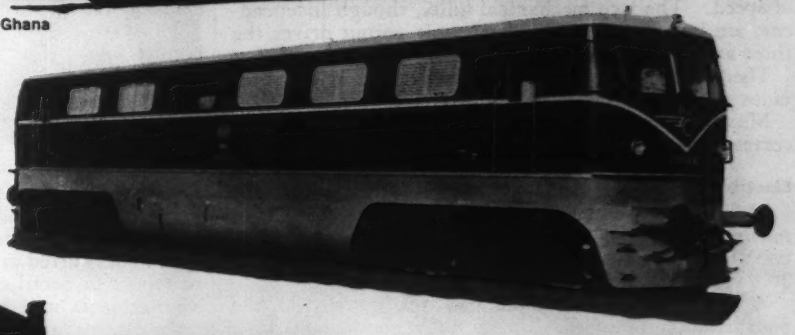


Fig. 7 Diesel-electric locomotive for Austria

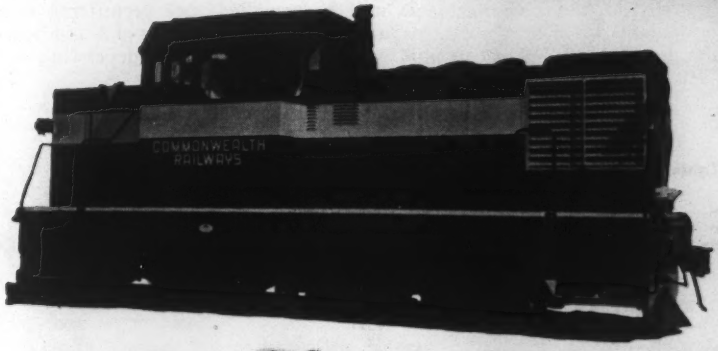


Fig. 8 Three-axle switcher for Commonwealth Railways

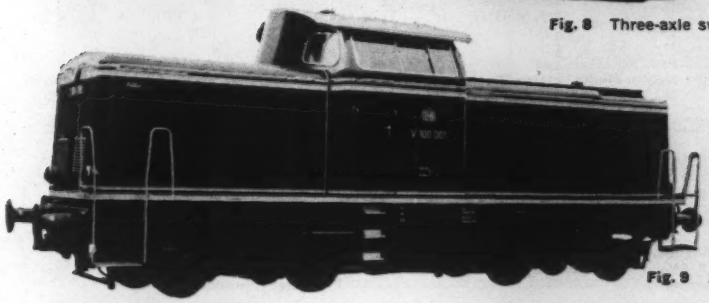


Fig. 9 1200-hp hydraulic-drive unit for Germany

locomotive, Fig. 15, item 14, Table 2. This 3000-hp unit is powered by the 12-cyl, two-stroke, opposed-piston engine already described.

Locomotive With Free-Piston Engine

Renault has undertaken the construction of a 2400-hp "turbo-diesel" locomotive, mentioned in last year's report, Table 3. There are two power plants, each consisting of a gas generator and turbine, symmetrically located about the center of the locomotive, Fig. 16. The gas generators are of the SIGMA free-piston type. The turbines, furnished by Rateau, are mounted in the cab and drive through reduction gears to a mechanical unit which provides means for reversing and for a change of speed. The two mechanical units, though independent, are housed together. Each unit output drives the three axles of one truck through gears and cardan shafts.

There is a 270-hp auxiliary diesel engine which provides power for accessories.

Maximum tractive effort is approximately 53,000 lb corresponding to 21 per cent adhesion.

Electric Locomotives

Metropolitan-Vickers is building 135 electric locomotives for the South African Railways which operate on 3000 volts d-c and are rated 1840-hp continuous at 26.5 mph, item 1, Table 4.

A 2500-hp electric locomotive for service on the Southern Region of the British Railways operates on a line having a nominal voltage of 675 volts d-c, Fig. 17, item 4, Table 4. A motor-generator set is used to provide for bucking or boosting line voltage to control speed [15].

Henschel announced the first of a series of 4-axle electric locomotives for the Central Railways of Brazil which have 1-hr rating of 3200-hp at 37-mph, Fig. 18, item 3, Table 4. Tractive effort is transmittted through a center pivot which projects into the truck bolster to the level of the center of the axle. This construction is said to alleviate weight shift on the truck.

A group of French locomotive builders has under construction 50 ignitron-rectifier-type locomotives for the Russian Railways [6]. Ten units geared for heavy freight traffic will have regenerative braking, 30 additional units will have freight gearing, and 10 units will have passenger gearing—the latter two types without regenerative braking, Fig. 19, item 4, Table 4.

The Bern-Lotschberg-Simplon Railway of Switzerland has been using a type AC 4/4 straight-electric locomotive of 4000-hp on four axles since 1944. In order to handle heavier freight traffic, the Railway, in conjunction with the Swiss Locomotive & Machine Works and Brown Boveri, recently evolved a modernized multiple-unit version of the type AC 4/4 locomotive which rates 7800 rail hp [16] for one hour [5], Fig. 20, item 5, Table 4.

Passenger and Freight Cars

The continuing de-emphasis of passenger traffic in the United States was accompanied by relatively little development of passenger equipment in this country.

Rapid-transit equipment has been more active with cars ordered by the Chicago Transit Authority and New York City Transit Authority with designs similar to previous purchases. The City of Philadelphia ordered 270 cars for the Market-Frankford Subway Elevated Lines from The Budd Company for delivery beginning in 1960. These are the first rapid-transit cars of stainless steel to be ordered in reasonable quantity. It is too early to report in detail on these cars. Briefly, two general arrangements will be provided, one permitting single-car operation, and the other, use in pairs of A and B units. The cars will weigh 53,600 to 56,000 lb, depending on the precise arrangement, Fig. 21.

Table 2 Diesel Locomotives (*Continued*)

Item No.	8	9	10	11	12	13	14
Builder—mechanical	MAK	Alsthom	English Elec.	British Rwys.	British Rwys.	Fiat	Kharkov
Builder—electrical		Alsthom	English Elec.	Clayton Equip. Co.	Crompton-Parkinson	Various	Kharkov
Owner	German Rwys.	Colombia	British Rwys.	BTH	British Rwys.	Italian State	Russian Rwys.
Service	Switching	P, F	Mixed Traffic	G.P.	G.P.	Mixed traffic	Freight
Wheel arrangement	B-B	C-C	B-B	C-C	1C-C1	B-B	C-C
Engine data:							
Engines per cab	1	1	1	1	1	1	1
Hp rating per engine	1200	1400	1100	1100	2300	1320	3000
Number of cylinders	12	16	9	12	12	12	12
Bore and stroke, in.	7.28 × 7.87	6.89 × 7.56		$8^3/_4 \times 11^1/_2$	11 × 14	$9 \times 10^1/_2$	$8^1/_8 \times 10$
Engine speed, rpm	1500	1500	1600	800	750	1000	850
Cycles	4	4	2	4	4	4	2
Supercharging	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manufacturer	Maybach	SACM-MGO	Napier Deltic	Lister-Blackstone	Sulzer	Fiat	Kharkov
Weight on drivers, lb	138,000	185,000	163,000	161,000	255,000	141,000	304,000
Total locomotive weight, lb	138,000	185,000	163,000	161,000	309,000	141,000	304,000
Fuel capacity, U. S. gal	700	815	660	600	1000	520	2000
Driving wheel diam, in.	$37^1/_4$	38	43	$36^1/_2$	45	41	$41^1/_2$
Type of transmission	Hydraulic	Electric	Electric	Electric	Electric	Electric	Electric
Track gage, in.	$56^1/_2$	36	$56^1/_2$	$56^1/_2$	$56^1/_2$	$56^1/_2$	60
Maximum speed, mph	60	40	75	55	90	62	$62^1/_2$
Figure number	9	10	11	12	13	14	15

BTH—British Thomson-Houston Co., Ltd.
Maybach—Maybach-Motorenbau GMBH, Germany
SACM-MGO—Societe Alsacienne, France
MAK—Maschinenbau Kiel Aktiengesellschaft, Germany
G.P.—General Purpose
P—Passenger Service
F—Freight Service

Fig. 10 1400-hp diesel-electric for Colombia

Fig. 11 British Railways 1100-hp diesel-electric

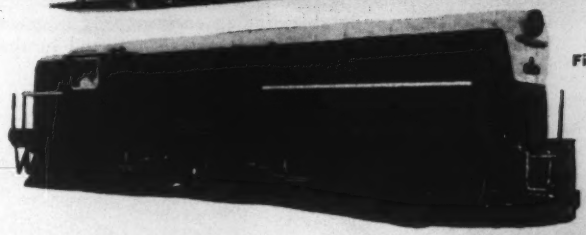


Fig. 12 British-built lightweight prototype unit

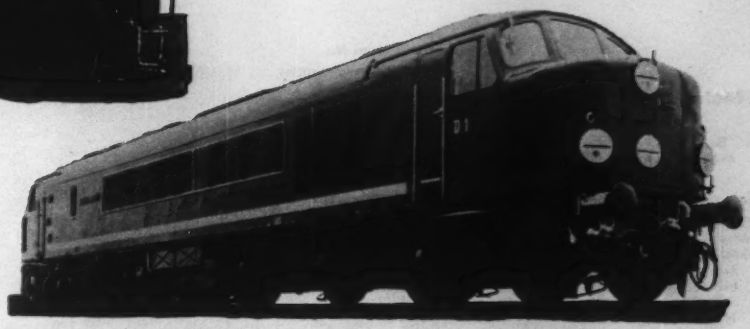
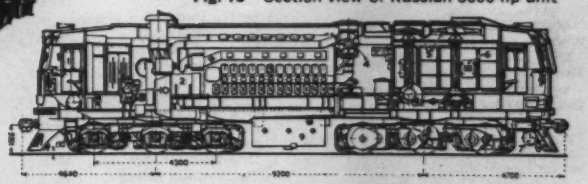


Fig. 13 2300-hp locomotive built by British Railways

Fig. 14 Fiat-built unit for Italian State Railways

Fig. 15 Section view of Russian 3000-hp unit



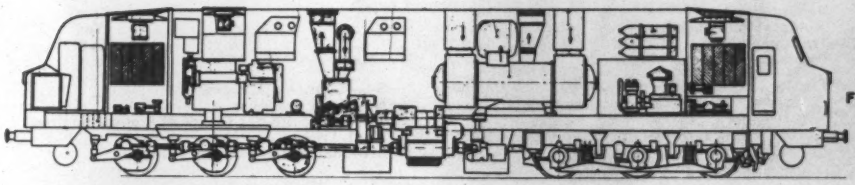


Fig. 16 Section view of Renault free-piston unit

ANNUAL REVIEW

1958 PROGRESS IN RAILWAY MECHANICAL ENGINEERING 1959

French Dome Railcar. Tailored for the French tourist trade, an 88-passenger, self-powered dome railcar is one of 10 that will go into service on the French Riviera and in the Alps, and is the first dome car in France, Fig. 22. The car, built by Renault at Choisy-le-Roi, is topped by a transparent glass and plastic dome. An 800-hp diesel engine lies beneath a soundproof floor in the center section of the car which is 91 ft long over buffers, 13 ft 10 in. high over the domes, and weighs 128,000 lb. Electric transmission is provided with traction motors on one truck only. It is designed for 100-metric-tons end load. It is not intended for operation with trailer.

Freight-Car Accessories. Developments in freight-car accessories have continued at a favorable pace with particular emphasis on special-purpose cars and accessories. Container systems for transportation by rail, highway, and sea have been especially active during the past year.

Republic Steel's Berger Division has developed a three-section corrugated steel cover to give all-weather protection to freight carried on gondola cars, Fig. 23 [17]. The covers fit any standard-width gondola, in lengths from 40 to 52 ft. The center section is equipped with a "lip" at either end to overlap the adjoining pieces and provide a tight seal. They are secured by special heavy-duty load binders.

Strain-Steel Corporation has developed an all-steel "Anchor Liner" and nailable doorpost for application to boxcars. The corrugated liner panels can be applied with various heights welded into a single piece. Fittings are provided for attaching strap anchors for securing the lading.

The steel doorposts strengthen the doorway area against lift-truck damage and permit repeated nailing of grain doors.

The Standard Railway Equipment Manufacturing Company has developed a container-transfer device for use where high-cost equipment is not warranted [18]. A portable mechanism permits lateral transfer of a container from a flatcar to a flat-bed trailer or loading dock. It consists of an inflatable-air-bag arrangement in combination with rollers. The roll unit is inserted in the fork-lift provisions of the container.

Table 3 Free-Piston Engine Locomotive

Builder—mechanical	Renault, Loire Foundry
Owner	SNCF[a]
Service	Passenger
Wheel arrangement	C-C
Gas-generator data:	
Number per cab	2
HP rating per generator	1200
Number of cylinders	2
Motor-cylinder bore, in.	12.3
Compressor-cylinder bore, in.	35.6
Stroke, in.	19.7
Manufacturer	SIGMA[b]
Gas-turbine data:	
Maximum speed, rpm	12,280
Reduction-gear ratio	6.14
Manufacturer	Rateau
Weight on drivers, lb	250,000
Total locomotive weight, lb	250,000
Driving wheel diam., in.	41.3
Type of transmission	Mechanical
Track gage, in.	56 1/2
Maximum speed, mph	80
Figure number	16

[a] Société Nationale Chemin de Fer.
[b] Société Industrielle Générale de Mécanique Appliquée.

Table 4 Electric Locomotives

Item No.	1	2	3	4	5
Builder—mechanical	M-V-B, P, Ltd.	British Rwys	Henschel	Alsthom and SFAC	Swiss Loco. Wks
Builder—electrical	M-V E Co., Ltd.	Eng. Elec.	S-S	Alsthom and SW	Brown Boveri
Owner	SAR	British Rwys	Brazil Central	Russian Rwys	Bern-L-S
Service	Mixed traffic	Mixed traffic	Freight	Freight	Mixed traffic
Wheel arrangement	B-B	B-B	C-C	C-C	B-B-B-B
Power supply	3000 volt d-c	675 volt d-c	3000 volt d-c	25,000 volt a-c	15,000 volt a-c
Power conversion	...	M-G booster	...	Ignitron rect.	Straight series
Current collector	Panto.	Panto.	Panto.	Panto.	Panto.
Driving wheels:					
Number	8	8	8	12	16
Diameter, in.	48	48	49	49.25	49.25
Weight, lb.					
Total	188,000	172,480	220,000	304,000	314,000
On drivers	188,000	172,480	220,000	304,000	314,000
Per driving axle	47,000	43,120	55,000	50,667	39,250
Dimensions, ft-in.					
Length, over-all	50-10	50-7	54-6	75-8	99-2
Width, over-all	9-6	9-3	...	9-9	9-9
Height, panto. down	13-5	13-1	...	16-1.75	14-9
Rigid wheel base	11-3	10-6	11-6	15-4	10-8
Total wheel base	37-0	37-6	37-9	56-11	85-8
Traction motors					
Number	4	4	4	6	8
Mounting	Axle hung	Bogie	Axle hung	Axle hung	Axle hung
Drive method	Gear	Spring	Spring gear	Gear	Gear
Gear ratio	18/67	22/76	1/4.41	1/4.43	1/2.22
Tractive force, lb					
One-hour rating	32,000	20,000	...	81,600	63,360
Per cent adhesion	17	11.6	...	27	20
Continuous rating	26,000	18,000	...	76,000	...
Per cent adhesion	14	10.4	...	25	...
Rail horsepower					
One-hour rating	2100	2510	3200	6336	7850
Continuous rating	1840	2320	...	5870	...
Speed, mph					
One-hour rating	24.5	47	37	29	6.5
Continuous rating	26.5	48.3	...	29	..
Maximum	60	90	62	62	77.5
Regeneration	Yes	No	...	Yes	4Yes
Multiple-unit operation	Yes	No	...	Yes	.Yes
Track gage, in.	42	56.5	63	60	56.5
Figure number	N.A.	17	18	19	20

Bern-L-S—Bern-Lotschberg-Simplon Railway
M-V-B, P, Ltd.—Metropolitan-Vickers-Beyer, Peacock, Ltd.
M-V E Co., Ltd.—Metropolitan-Vickers Electric Co., Ltd.
SAR—South African Railways
S-S—Siemens-Schuckert
N.A.—not available
SFAC—Societe des Forges et Ateliers du Creusot, France
SW—Materiel Electrique, France

Fig. 17 British Railways electric locomotive

Fig. 18 German-built 3200-hp unit for Brazil

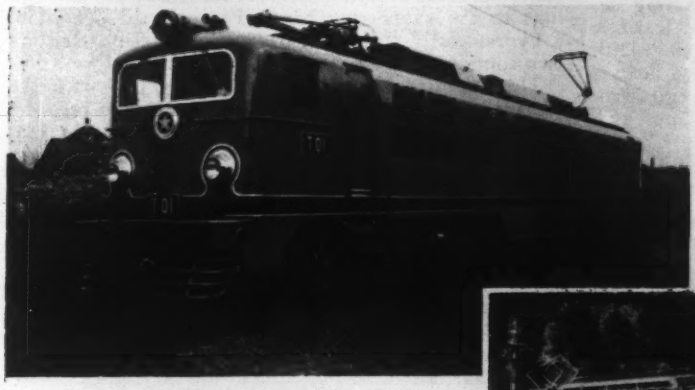


Fig. 19 French-built 6000-hp unit for Russia

Fig. 20 Swiss-built 8800-hp two-unit locomotive

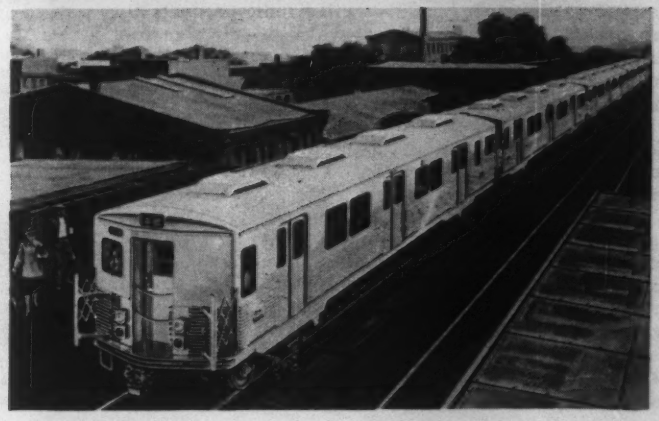


Fig. 21 Plan of equipment for Philadelphia Rapid Transit

When air is applied, the container is lifted free of its locking device and may be rolled to the other vehicle. Rolling may be accomplished by use of a hand winch or auxiliary hydraulic equipment.

The C & O Railroad has developed a new device to increase the energy-absorbing capacity of freight-car draft gear [19]. The rear draft stops are permitted to move with relation to the standard center-sill but connected to each other by means of a compression-resisting tube which is permitted to slide with relation to the car underframe. In this way the buffing shock is absorbed by both draft gears rather than the one at the end where the shock is applied.

A special chain-cushioning and load-restraining device has been developed for test by the Elgin, Joilet & Eastern and The Brandon Equipment Company [20]. This has been applied to two boxcars and two flatcars especially to restrain tin plate either in sheet or coil form.

Turnbuckles working through springs clamp this loading to a frame. This frame is then cushioned in a longitudinal direction against members which are fastened to the car. Tests show a considerable reduction in damage during transit.

Freight Cars and Containers. The Union Tank Car Company has leased to the Pennzoil Division of South Penn Oil Company four large tank cars, each of 22,000-gal capacity [21]. Reportedly the largest leased tankers ever built, they are 67 ft 8 in. long, 14 ft 5⅝ in. high and 9 ft 6 ⅜ in. wide. Each weighs 91,900 lb, has a load limit of 159,000 lb, and can carry four different products in as many compartments. Each of these "jumbo" cars thus does the work of three cars of normal capacity.

In the category of special-purpose freight cars, General American Transportation Corporation has exhibited a new covered-hopper car called the "dry-flo," designed to handle dry products, Fig. 24 [22]. This car, available in 2450 or 3500-cu-ft capacity, will handle products not capable of fluidization and provides 10 circular roof hatches for loading. It is unloaded by either vacuum or pressure pneumatic systems, gravity feed, or any mechanical-conveying system.

Trailer Train has ordered 400 new cars from Pullman Company and 400 similar cars from ACF. These cars are 85-ft flatcars designed to hold two 40-ft trailers each in trailer-on-flatcar service.

The Missouri Pacific Railroad has developed a refrigerated container for rail or highway transportation. This container is mechanically cooled by propane-driven refrigerating units with 6 in. of insulation provided all around. The cooling capacity permits holding at −10 F with +100 F ambient or 50 F inside with 0 ambient.

The Southern Railway has ordered 1205 100-ton capacity, roller-bearing gondola and covered-hopper cars with aluminum bodies [23]. Pullman is building 750 gondolas, each having an inside width of 11 ft, inside height of 11 ft, and inside length of 50 ft which can carry 103 tons of coal. Magor Car Corporation will build 455 composite aluminum-steel covered-hopper cars for bulk commodities. Three sizes are being built due to weight differences in commodities to be carried—200 of 2600 cu ft, 215 of 3818 cu ft, and 75 of 4605 cu ft. All of the cars are scheduled to be delivered by the end of 1959. A comparison of initial costs and weights with conventional 70-ton hopper car is as follows:

	103-ton aluminum-steel gondola	70-ton steel hopper car
Cost	$20,000	$12,500
Load tons	103	74
Tare tons	22⅓	31
Gross tons	125⅓	105
Tare weight, per cent	18	29.5

Three of the new 103-ton cars will handle 13 tons more revenue freight than four of the conventional 70-ton steel cars, with 43-tons decrease in gross train tons.

Pullman-Trailmobile has developed a container system for the Matson Navigation Company, designed for combined sea and rail transportation. It is in use for transporting canned pineapple from Hawaii to Chicago. The container is 24 ft long, 8 ft wide, and 8½ ft high. Each container locks at each of the four corners by pin-through lugs to the supporting base. For railroad operation, a hydraulically cushioned base is provided, handling two containers on a flatcar.

The Canadian National Railways, together with the Canadian Car Company, have for some years been developing the large-size automobile-transporter car, Fig. 25. Of the order of 125 cars announced by the CNR last September, 50 will be 75 ft long and 16½ ft high, and will handle eight American-size cars or 10 European cars; 75 cars will be a smaller version, handling six large or eight small autos. Autos are carried on two decks, loading and unloading under their own power.

Acknowledgments

The Committee on Survey wishes to acknowledge with sincere appreciation the generous assistance given by the various trade magazines, and by the railroads, locomotive and car builders, and equipment suppliers, in making information available for the report.

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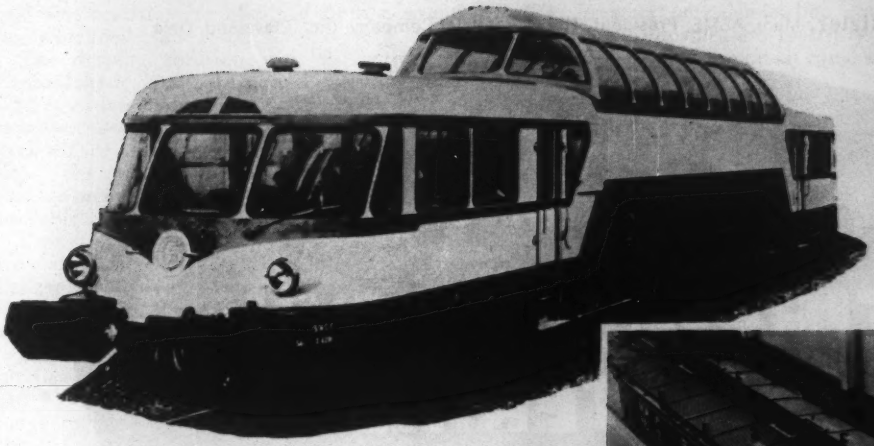

Fig. 22 French-built dome railcar

Fig. 23 Gondola car with corrugated covers

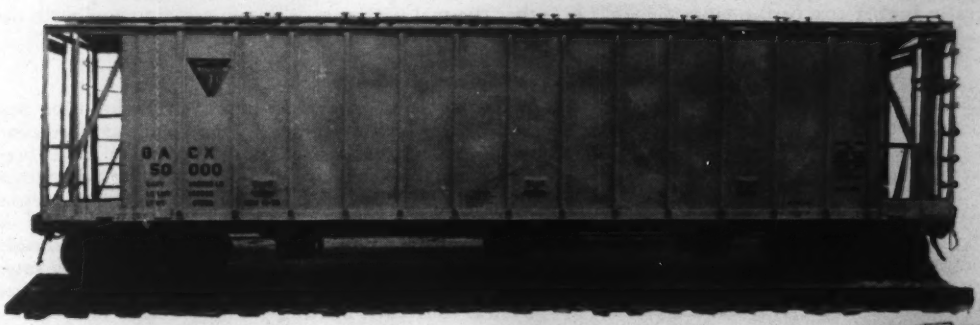

Fig. 24 3500-cu ft covered hopper car

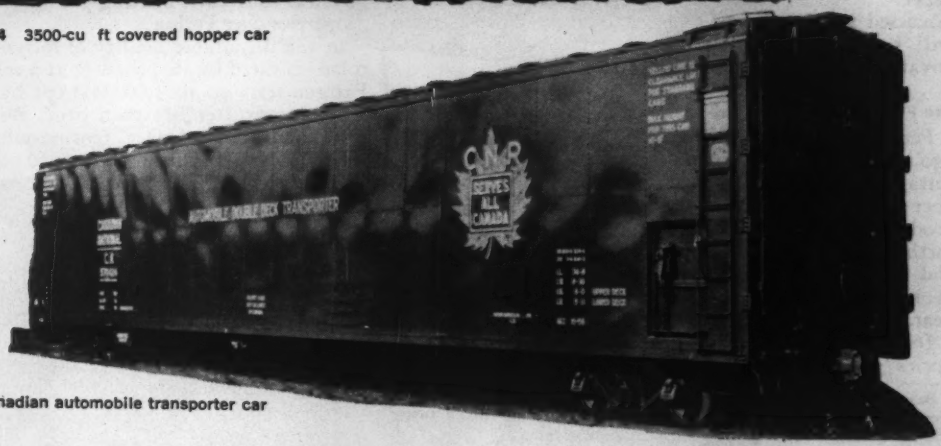

Fig. 25 Canadian automobile transporter car

By **C. A. Litzler**, Mem. ASME; President, The C. A. Litzler Company, Inc., Cleveland, Ohio

Wire, glass fiber, and new textile fibers show promise as reinforcing cords for tires. This report is a briefing on current tire developments in Europe as well as America.

COMPLETELY new cord materials are being developed to increase the dependability of tire cord and cord fabric for the greater tire mileage, increased tire safety, and generally higher tire performance demanded by increased road speeds. In the past 20 years, there have been 11 varying types of fiber introduced for tire use, and eight of these have been introduced in the past 10 years.

There has also been a rapid forward stride in the overall tenacity of textile fibers produced for tire use, increasing in 18 years from 3.6 grams per denier to 7.5 grams per denier.

The growth pattern of tire cord up to 1958 shows a steady gain in noncellulosic cord fabrics and a partial reduction in conventional rayon fabrics. Rayon and nylon-cord developments are beyond the scope of this paper. Seven new fibers or reinforcing materials will be discussed in some detail and other promising materials will be given briefer treatment. Tire-production innovations other than cord will also be included.

The Perlon Group

Perlon fiber was developed originally about 20 years ago in Germany, and for some time it was thought to be suitable for tire-cord use. It is a caprolactam-based fiber and is generally known as Nylon 6. Although it is produced in the U. S., it will be little used in tires until further development has increased both its melting point and tenacity. Use has gradually diminished in Europe as more promising related materials made their appearance.

Its main physical deficiencies for tires arise in two categories: (*a*) Its low heat stability and generally low level of thermal constants; (*b*) its medium tenacity as compared to today's accepted maximum.

The melting points, the optimum fixation point, and other thermal constants of Perlon are compared with the same general data for Nylon 66 in Fig. 1.

The Caprolan Amides

Caprolan is an American-improved Perlon-type material of the Nylon-6 group. The chemical fiber compounds known as epsilon polycaproamide have been developed for over 50 years. Recent chemical innovations and developments have rendered this fiber acceptable for tire-cord use. It differs from Nylon 66 in lower melting point, somewhat better thermal shrinkage, and retained-tensile-strength properties at elevated temperatures. Caprolan has considerably improved physical constants, melting-point, and high-temperature properties over Perlon.

In the disputable quality of fatigue value, HBT Caprolan[1] is rated by its producer at a relatively high level. Fatigue tests up to 3,600,000 cps have shown a 2.0 to 2.5 times greater life than other fibers under Rotoflex test conditions. Under tension-vibration tests, Caprolan, running to failure, shows a 10 per cent improvement over the other fibers tested. The tensile-load-elongation characteristic is quite favorable to other fibers in both the greige cord and in the dipped and multiple-zone-stretch and treated conditions.

The stress-strain curve for Caprolan cord of 840/2 denier in treated and untreated conditions shows that elongations at load levels of 5 and 10-lb stress are within the limits of cord requirements for most commonly used tire designs. The treated cords were processed in a triple-zone 5-end Computreater laboratory unit, Fig. 2,

Based on a paper contributed by the Rubber and Plastics Division and presented at the Semi-Annual Meeting, St. Louis, Mo., June 14–18, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] HBT = high tenacity, bright, thermally stabilized—the particular grade of Caprolan used.

and test results were obtained by a conventional IP4 Scott inclined-plane tester.

The dipping solution was conventional resorcinal formaldehyde latex, RFL, in 12 per cent solids range. The dried-latex deposition on the cord was in the usual neighborhood of 5 to 6 per cent. The cord was given a preliminary water dip and then the RFL conventional dip. The treating conditions which are readily reproducible on existing dipping and treating lines are shown in Table 1.

Dipping tensions of $^1/_4$ lb per cord are commonly used for conventional rayon and nylon cords and well within the range of most modern dipping systems. The drying tensions are in the approximate range of 1 lb per cord, which is also acceptable.

Stretch ranges in the order of 14 per cent indicate a produced cord tension (at the stretching temperature of 410 F) of approximately $7^1/_2$ to 8 lb per cord. This range requires 15,000-lb maximum-tension capacity in the heat-set unit. This tension capacity is also well within the range of existing modern treating systems.

Normalizing or relaxation of the cord was accomplished at $1^2/_3$ lb per cord with a residual shrinkage in that zone of $2^1/_2$ to $3^1/_2$ per cent. Both the lower impressed tension and the resulting shrinkage in length are minimum requirements and readily obtainable in most commercial units.

Treating of the fiber cords or fabrics is now being accomplished on several existing multiple-zone fabric treaters or calender-line equipment. In fact, several tire companies are presently using Caprolan cords in a limited measure on an equal specification basis with Nylon 66.

The capacity of Caprolan to retain tenacity at elevated temperature is comparatively high. The heat-degradation relationship at various temperatures is compared to the "retained original tenacity" in Fig. 3. Normal tire use does not ordinarily exceed 120-C internal carcass temperatures.

From the viewpoint of "zero-load temperatures," Caprolan has excellent qualities and performs well under other high-temperature conditions with increasing preloaded tension, Fig. 4. In untreated conditions, Caprolan begins to degrade at 230 C after the application of 2300 grams loading on the basis of 840/2 cord.

The general characteristics of Caprolan are given in Table 2. Although these do not generally relate to the characteristics usually considered for tire-cord uses, they help to complete the over-all picture of the material.

The Polyester Group

The polyester group, which has advanced experimentally for tire-cord use, originated in England about 10 years ago. It is known locally as Dacron, abroad as Terylene, Diolen, and Tetoron. The differently named materials are all basically polyethylene terephthalate and are the product of terephthallic acid, dimethyl ester, and glycol.

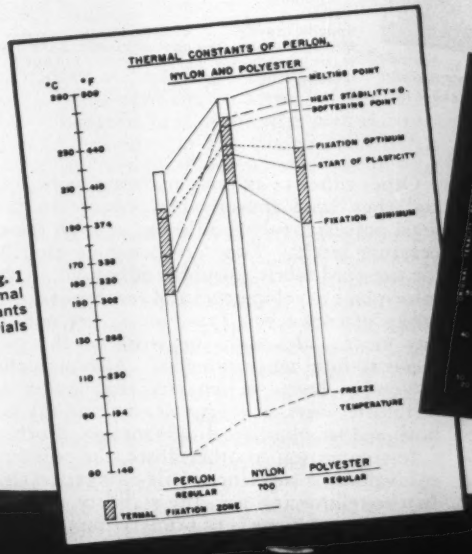

Fig. 1 Thermal constants of materials

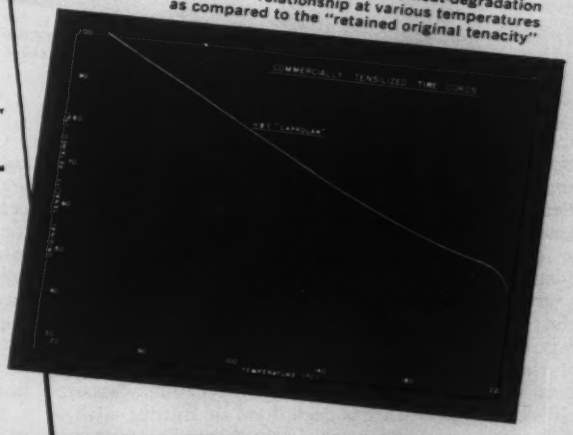

Fig. 3 The heat-degradation relationship at various temperatures as compared to the "retained original tenacity"

Fig. 2 The Caprolan cord was processed in a triple-zone, 5-end Computreater laboratory unit. Test results were obtained with a conventional IP4 Scott inclined-plane tester.

NEW TIRE-REINFORCING MATERIALS

Table 1 Typical Conditions for Caprolan-Cord Treatment, Denier 840/2

	Time, sec	Temp, deg F	Tension, lb	Stretch, per cent,
Presaturation	..	Room	0.165	0
Latex dip	..	Room	0.254	0
Drying oven	160	280	0.992	0
Hot stretch	30	410	...	14
Normalizing	30	380	1.65	..
Cooling-winding	40	Room	0.150	..

NOTES: Breaking strength, 29–30-lb range; latex dip, standard resorcinal formaldehyde latex, 12 per cent solids hot stretch, operated at constant stretch; normalize, operated at constant tension; treatment, Computreater lab unit

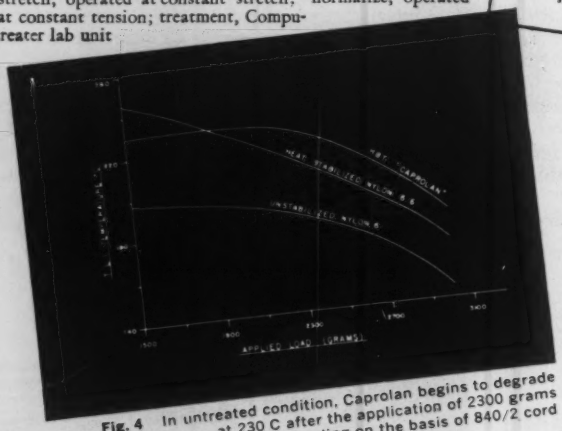

Fig. 4 In untreated condition, Caprolan begins to degrade at 230 C after the application of 2300 grams loading on the basis of 840/2 cord

Fig. 5 At 120 C, the tenacity of polyester yarn is approximately 4.6 grams per denier

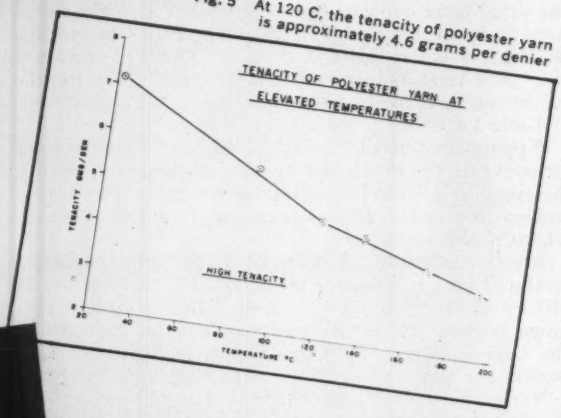

Table 2 Average Physical Properties of Caprolan of High-Tenacity, Bright, Heat-Stabilized, 840-Denier Type

Tenacity, grams per denier	
Standard	8.4
Wet	7.6
Standard loop	7.0
Standard knot	6.3
Tensile strength, psi	122,000
Elongation at break, per cent	
Standard	18
Wet	22
Specific gravity	1.14
Moisture regain, per cent at standard conditions	4.5
Water absorbency, per cent at 95 per cent R. H.	7.8
Melting range, deg C	212 to 220

The polyester filaments have a uniformly round cross section and are basically soft and subtle and have a reasonably high gram-per-denier strength. They have excellent strain-load characteristics and excellent high-temperature stability.

The Adhesion Problem. Aside from other technical considerations, the basic problem encountered in polyester rubber systems has been the adhesion of the cord to the elastomer. Many experimental tires have been built from polyester and quite successfully run. However, all of these test tires have been built from fabric which has been hot stretched and treated with xylolisocyanate adhesives. Some work has been done in Europe utilizing tri-isocyanates and methyl-ethylketone-solvent vehicles.

The use of solvent dips is not a practical solution to the polyester-adhesive problem as there are very few treating machines available now for solvent dips. The industry, almost universally, is now using aqueous solutions of RFL or pyridine adhesives.

About one year ago, E. I. du Pont de Nemours & Company, Inc., announced the development of an aqueous-based adhesive for Dacron polyester fibers-and-rubber systems. It was introduced primarily for use in V-belt cords, hose, and possibly Dacron rubber-coated fabrics. High-level operation has been experienced in these systems. Although some experimental tires have been built, Hylene, as it is called, is not recommended.

Other adhesive systems are being worked on elsewhere and they hold considerable promise to produce high-level polyester-rubber adhesive at high fatigue and temperature levels. They are being developed principally for tire-cord fabric-to-rubber adhesion. Laboratory and pilot-plant developments and test results of the polyester group of cord-fabric types are as yet not conclusive by any means, although the work of the past five years seems to hold much promise. Although the material is somewhat lower in tenacity than nylon and the new cellulosic fibers, it seems to combine the advantages of both and to eliminate disadvantages of other materials.

In comparison to other fibers, the polyester group has equivalent or superior tensile-elongation characteristics. In tire-reinforcing use, the stability of the fiber at elevated temperatures is of primary importance. At 150 C, the greatest degradation occurs during the first 168 hr. After that, the reduction of tenacity versus time diminishes greatly. The cord strength at elevated temperatures is greatly in excess of any normally required.

The treating ranges of polyester cords for tire use are well defined by a considerable amount of completed laboratory work, and stretch characteristics at 5 and 10-lb load levels are suitable for tire-cord use.

The Thermal Constants of Polyesters. The start of plasticity of the filament, the softening point, and the zero-heat-stability range are important criteria for the judgment of the fiber suitability. Polyester, the Perlons, and

the nylons are briefly compared in Fig. 1. Significantly, tensile strength is relatively high and elongation is comparatively low. These conditions, in addition to relatively high-temperature stability and high-fatigue level, are excellent for tire use. Several sources report that the polyesters have been fully approved and standardized upon by the USSR air force for all aeronautical-tire use. If this is true, it lends credence to the greater use predicted by many European tire and textile engineers and designers.

The relationship of the tenacity of polyester yarn at elevated temperatures is shown in Fig. 5. At the 120-C tire-temperature level, tenacity is approximately 4.6 grams per denier. Laboratory treating and testing were done on Computreater laboratory equipment.

The Wire Tire

The increasing success of the wire tire on the Continent has created major interest in the U. S. and elsewhere. Wire tires are principally used for trucks and buses and, in some cases, for off-the-road tires. Mileage life with relatively smooth road surfaces is very high, and phenomenal in some reported cases.

The importance of this type of heavy-duty tire is demonstrated by the usage of high-carbon tire wire in the U. S. which is now at the 6,000,000-lb-per-yr level and expected to reach 12,000,000 lb per yr by 1972 or 1973. Nearly all major American producers are making wire tires, either under foreign technical-license agreements or by independent work of their own. Continuous development work on new designs, cord constructions, rubber compounds, and manufacturing techniques is under way.

Conventional tire designs are used in some cases, but the characteristics of the material also allow, or rather require, a radically different tire construction known as the radial ply. The strain load of the wire cord also permits considerable ingenuity in tire design, which has produced a novel and unique European tire design that will be described more fully.

The cord wire itself usually consists of seven 3-wire strands of which six are concentrically stranded around a middle triple-wire strand, although another commonly used construction employs five strands of seven wires. Individual strands in the first construction are triple strands of 0.0058-in-diam individual wires. The cable lay is a nominal 0.340 in. All wires are usually brass-plated. The tensile strength of the individual wires is in the range of 400,000 psi. Cord diameters are about 0.035 in. ± 0.001 in. over the brass plating.

Stress-strain curves of both types of cord are shown in Fig. 6. These indicate very high breaking strength and excellent elongation characteristics. Fatigue ratings of these two cord constructions are very high, and tire life even under heavy service loads exceeds that of heavy-ply tires constructed of high-tenacity fiber cord.

The wire carcass performs well under off-the-road service with adverse conditions. The low elasticity of wire strand is offset by its high tensile strength. Even in dual-tire application under some tire conditions, stone pickup and consequential bruise between adjacent side walls do not cause unduly short carcass life.

Two basic types of conventional wire truck tires are being produced in the U. S. A conventional 4-ply wire-constructed tire for medium-sized trucks uses body plies of conventional bias angle and bead warp, and a conventional tire construction with a total build-up of only two body plies, which is shown in Fig. 7. The tire performs well and runs cool under medium service conditions for normal non off-the-road tires, such as bus and unpowered-trailer use.

The construction of the one-ply radial-type tire, known as French type X construction, is shown in Fig. 8. The side wall proper consists of one single radial ply of wire-cord fabric extending from the bead-wrap area, around the side wall and crown and the under-tread portion of the tire cross section. The cross-over angle is 180 or 0 deg depending upon the individual conception of tire design. In any event, the reinforcing cords run from bead to bead at an angle of 90 deg from the bead.

Directly on the first radial ply a circumferential narrow extension ply is positioned on the tread center line. This ply or extension band has a very low bias angle in relation to the first-ply 90-deg bead angle. Additional and wider plies diminish in width, generally in relation to the tire and tread cross section.

This construction provides a flexible side wall with low side-wall temperature build-up. The five additional under-tread breakers insure a very firm under-tread support which provides exceptionally long tread life. The single-ply side wall provides easy riding qualities and good springing characteristics.

The fourth type of wire-tire construction, still in the development state, is known in Italy as the belt-type or "Cinturata radial" tire, and combines the advantages of a fiber tire and the high strength of a wire-tread platform. These are combined with an outer replaceable tread by which bands having several different road-approaching surfaces can be substituted for different road surfaces or snow or ice service. The carcass plies are all in parallel and the textile cords are arranged radially from bead to bead as in the previous type of tire. In addition, there is some metallic ply under the tread. These wires are arranged almost circumferentially in a precise geometric-band weaving or roving. One European producer reports that this type of tire is increasingly used for replacement of conventional tires even for automotive use.

European producers are using cord wire of many different constructions, beginning with a total of 21 individual wire filaments in seven 3-strands and extending to a maximum of 63 filaments stranded in 21 3-wire cords. Tensile strength of these wire cords extends from approximately 180 lb to a maximum of 700 lb depending upon the strand-up of the individual cord. Lower twists in the cable construction are being used in wire cord and various twist arrangements to produce different strain-elongation characteristics, Fig. 9.

Treatment of Wire-Tire Carcass Fabric. There is some difference of opinion as to the best method of carcass-wire treatment both as to the adhesion system and as to calendering methods. Most tire wire is brass, zinc, or galvanized-plated at the wire mill by continuous electrolytic methods when the wire is drawn down to about 0.032 in. diam. The filament gage is later reduced to 0.0058 in. with sufficient plating retained to assure adhesion of the rubber. The zinc (or other) plating is retained in the final wire assembly. Spooled wire is shipped in dessicated packages. These spools are creeled ahead of the calender in a conventional air-conditioned creel under accurately tensioned condition. The wire is cold-rubber calendered and then further processed in a more or less conventional manner.

The other currently used calendering method is lamination, where previously calendered gum stock is simul-

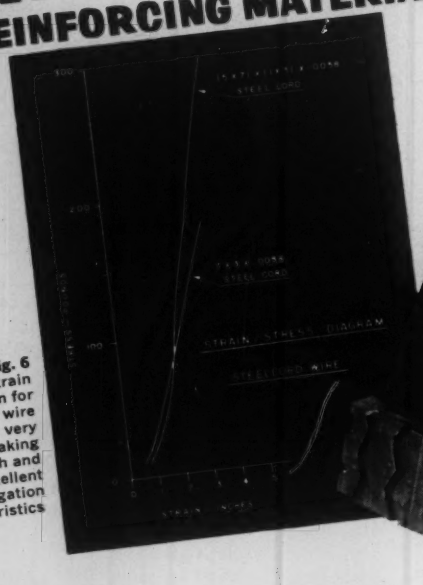

Fig. 6 Stress-strain diagram for steel cord wire indicates very high breaking strength and excellent elongation characteristics

Fig. 7 Conventional tire construction with a total build-up of only two plies. The bias angles are in the conventional range with the two wire breaker plies setting at opposing conventional bias angles. Bead construction and tie-in are nearly conventional.

taneously applied to both sides of wire cord which is handled in a weftless sheet. Each arrangement has problems of its own and generally local conditions affect the selection.

In an effort to increase wire-to-rubber adhesion, some tire manufacturers are considering the use of the plated wire, continuous cleaning, degreasing, and cementing of the cord in fabric form. Two of these systems are now undergoing experimental work and evaluation.

Glass-Fiber Tire Cord

Glass-fiber tire cord has been a long-range goal of the producers since 1940, and in 1945 a small tire company and a glass-fiber company undertook a full-scale program to develop a glass-fiber tire. Passenger-car tires were built of glass cords using the filament construction and low rate of twist then deemed practical. The filament was finally woven into suitable familiar-type fabrics and subsequently treated. High rates of internal cord chafing were suspected and the fabric and tire design supposedly took these into full consideration. The cord fabric was woven and preadhesive treated with a solution-nylon adhesive for adhesion of the resorcinal formaldehyde latex, RFL. After the adhesive treatment, the cords were given a suitable RFL pretreatment for the rubber bonding. The fabric was then rubber calendered in the usual manner.

Conventional tire construction was used with normal ply and bias angles and conventional rubber compounds, tread designs, bead wraps, and the like. Tires failed in less than 100 miles because of the partially expected filament self-abrasion.

Recent combination of silicone-rubber polymer with different tire-cord construction, different adhesive system, and special building and processing techniques in the U. S. has given temperature ratings 100 to 110 per cent higher than those of any conventional rubber tire yet produced. The new viewpoint considers glass as a material of high tensile strength, low extensibility, and a short rupture cycle. Test tires patterned after wire-tire construction and not fibrous-tire construction have been built with better results, but cord breakage and tread separation at 1000 or 1100 miles were average because of filament abrasion and adhesion difficulties.

A special glass-fiber laboratory is being planned outside the U. S., and a major effort is being applied to filament finishes or lubricant to reduce abrasion and therefore increase fatigue life. Although these developments are not on a scale approaching a major effort, the technical problems appear to be reasonably near a practical solution.

The Polyurethane Group

The fiber industry has long suspected that the polyurethane family would provide a monofilament of exceptionally good fatigue and tensile characteristics. In European development over the past three or four years, polyurethane-rubber treads or Vulcollan or Adiprene have shown tread life to a 50 per cent residual-tread depth at 28,000 miles of test-wheel operation.

Several years ago an all-polyurethane tread and polyurethane-fiber carcass developed by the European fiber industry in co-operation with its chemical industry was reported to have a tire-life expectancy of 75,000 miles or more. Verification of these test mileages is expected in future announcements. European production figures on polyurethane fibers in heavy-denier constructions give credence to the reports and indicate the probable future importance of this fiber.

Future Fiber Possibilities

Several other relatively little-known fibers being produced here and abroad may have some qualifications for tire-cord use. Polypropylene is a newly produced American fiber which seems to show some promise. Its apparent deficiency in thermal properties can probably

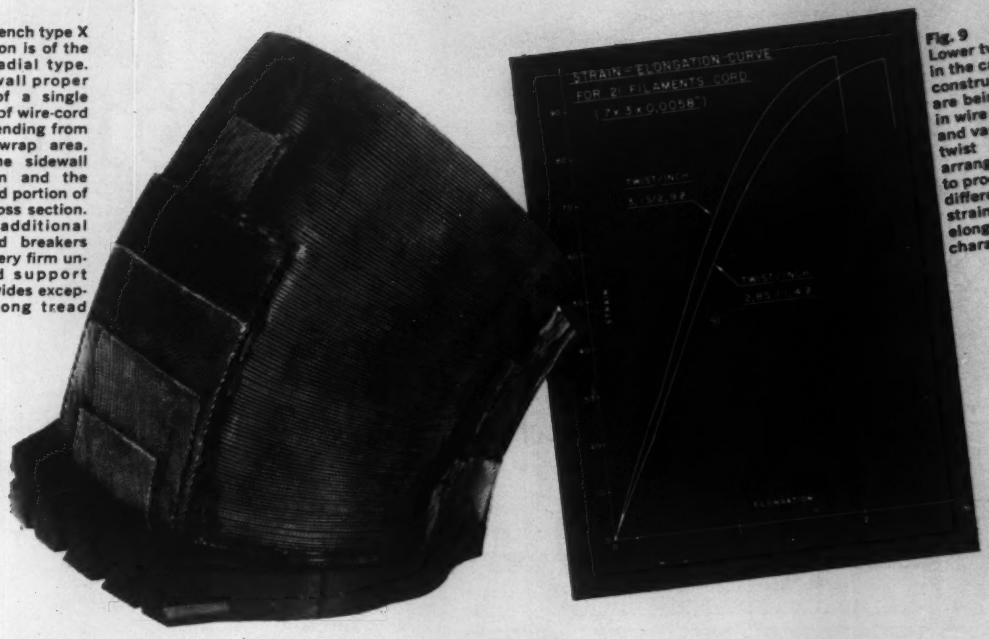

Fig. 8 French type X construction is of the one-ply radial type. The sidewall proper consists of a single radial ply of wire-cord fabric extending from the bead-wrap area, around the sidewall and crown and the under-tread portion of the tire cross section. The five additional under-tread breakers assure a very firm under-tread support which provides exceptionally long tread life.

Fig. 9 Lower twists in the cable construction are being used in wire cord and various twist arrangements to produce different strain-elongation characteristics

be overcome. Its other known qualities point to some tire-use possibilities. Vinylidine-chloride monofilament which is now making its American debut is as yet being produced in deniers that are too fine for heavy-tire use, but the characteristics the material possesses indicate that it is worth some further experimental work.

A Japanese material called Urylon is a chemical combination of urea and amide polymers and is currently in pilot-plant production. Development thus far has been for apparel textile purposes. In its present state, the material develops about 6 to 7-grams-per-denier tenacity, and has ultimate elongations of approximately 22 per cent. The stress-strain conditions at 5 and 10 lb seem adequate. Moisture resistance is 0 deg under any and all moisture temperatures. Thermal stability, so far as known, is equal to conventional accepted cords. The adhesion system is still undeveloped. Cost would be reasonably good, especially when volume of the material builds up.

Developments Other Than Fiber

A semirigid polyurethane-foam-filled tire, recently announced, would obviate the use of inner tubes, inner lining, or any other air-retaining membrane within the tire. Blowouts from any cause and air losses of any type are completely avoided. The tire is claimed to be completely roadworthy and safe even under conditions where any air-inflated tire would certainly fail, whether tubeless or dual-tube type. A similar development, observed over two years ago in Europe, differed principally in the carcass construction. The European experimental tire had a completely molded polyurethane carcass filled with a premolded inner ring (or rings) of cellular polyurethane. Extreme road or service indestructibility and safety were indicated.

Conclusions

The situation in tire-cord developments at this time, is as follows: (*a*) Cellulosic fibers, since their technical reincarnation, are providing a serious comeback for the all-important tire-cord market; (*b*) Nylon 66 materials undoubtedly will continue to advance technically and commercially in the premium or 1100/1200-level tires of passenger and other sizes; (*c*) wire-reinforced tires most probably will double in production quantities in the next several years with emphasis on bus and city-truck uses on firm and relatively smooth pavement surfaces; (*d*) Caprolan-type fibers will increase in use in nearly direct proportion to the comparative cost of cellulosic and amide materials; (*e*) the other newer and commercially untried materials mentioned will certainly make a strong future bid for the large-tire markets with the polyesters, which are the most advanced commercially or technically, probably the first serious contenders.

Acknowledgments

Technical data was received from the following sources: (*a*) On wire tires—Firestone Tire & Rubber Company, Akron, Ohio; Pirelli, S. p. A., Milano, Italy; (*b*) On glass tires—Mr. Ralph Reel, Dayton, Ohio; B. F. Goodrich Company, Akron, Ohio; (*c*) On polyesters—Imperial Chemicals, Ltd., Harrogate, England; Teikuko Rayon Company, Osaka, Japan; E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.; Continental Gummi-Werke, Hannover, West Germany; Armstrong Rubber Company, West Haven, Conn.; (*d*) On Caprolan—Allied Chemical & Dye Corporation, New York, N. Y.; *Modern Textiles Magazine*, New York, N. Y.

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Turbine-

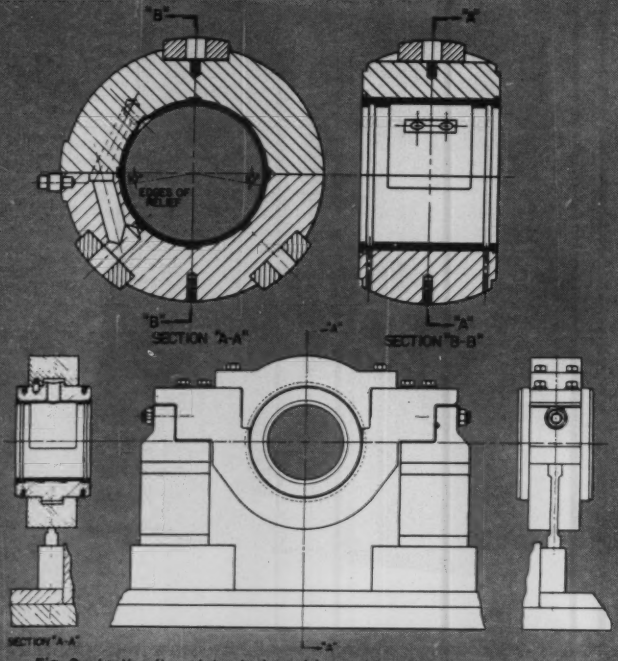


Fig. 1 In the spherically keyed bearing, one of the most widely used types of journal bearing, angular alignment, is achieved by the sliding of the spherical keys in the spherical seat

Fig. 2 In the flex-plate design of journal-bearing support, any angular misalignment of the journal and bearing will cause a bending and/or twisting moment on the flexible support plates which deflects them in a manner that will reduce the angular misalignment

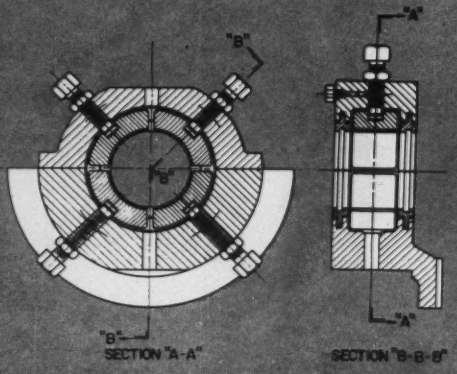


Fig. 3 In this multiple-pad type of journal bearing, each pad is supported on a spherical button which enables it to completely align itself to the journal

THE ECONOMICS involved requires bearings for electric-utility turbines and the larger-sized industrial units to be very conservative in design, and they normally lead relatively inconspicuous and trouble-free lives. Recent developments have permitted marked improvement in machine design through control of the occasional troubles that do arise. These are to some degree common to a large class of bearings. Some of the designs employed by the author's company, and some of the more important and interesting reasons for using these designs will be reviewed.

Journal Bearings

The usual functions of journal bearings are almost invariably well served. Because of the use of appropriate bearing-load limitations, turning-gear operation (extremely low speed) has been no problem in recent years even though turning-gear speeds have been reduced in some cases. The policy of purposely maintaining bearing loads at very conservative levels at all times for reliability reasons is felt to be basically sound although there are some obvious drawbacks. This conservatism made it possible, for example, for a 14-in-diam bearing to operate at 3600 rpm for over $1^1/_2$ yr with a blockage in the oil-supply line sufficiently large to cause the supply-oil pressure to fall to − 9 psig. Test instrumentation had made it apparent for some time that something was radically wrong in the oil-supply line, but bearing operation still had sufficient margin to permit unrestricted operation until a scheduled inspection. Had the design been less conservative, a serious outage could have resulted.

Angular alignment of the bearing to the journal is one of the most important aspects of bearing operation, and exerts such a strong influence that bearings may be typed according to this feature. One of the most widely used types of journal bearings is the spherically keyed bearing, Fig. 1, in which angular alignment is achieved by the sliding of the spherical keys in the spherical seat. Most of the bearings on a modern unit are of this general type. However, this bearing does not readily align itself to the shaft once it is carrying load, because of the relatively large friction forces at the keys. Consequently this type of bearing usually is not employed on the hot end of large machines where temperature-caused distortions would require frequent angular shifting of the bearing to maintain adequate alignment. As a result of a number of cases of cracked babbitt (a fatigue problem) some 15 years ago, resulting principally from these reasons, the flex-plate design of bearing support illustrated in Fig. 2 was developed. The support is so designed that any angular misalignment of the journal and bearing will cause a bending and/or twisting moment on the flexible support plates which will deflect the plates in a manner to reduce the angular misalignment. This design has been quite successful. Very few cases of cracked babbitt have occurred on bearings supported in this manner. In

[1] Design Engineer.

Contributed by the Machine Design Division and presented at the Annual Meeting, Atlantic City, N. J., November 29–December 4, 1959, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. ASME Paper No. 59—A-127.

Bearing Design

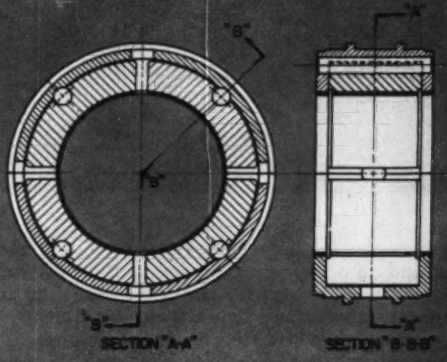


Fig. 5 One usual type of tilting-pad journal bearing permits the pads to rock on pins in order to achieve angular alignment

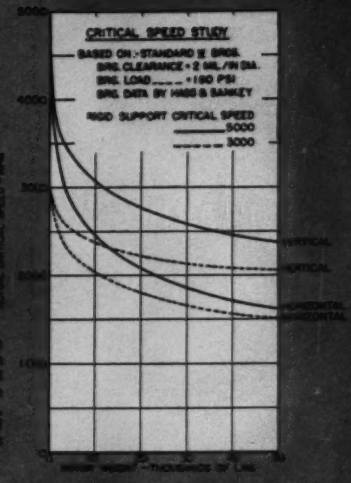


Fig. 4 Conventional oil-film journal bearings exert a very strong beneficial influence on the unbalance vibration of rotors, particularly at critical speeds

By Paul C. Warner, Assoc. Mem. ASME
Westinghouse Electric Corporation,[1] Steam Division, Lester, Pa.

Electric-utility turbines require the ultimate in bearing reliability. Current research ranges from oil-film damping to electrical pitting. Warning devices with hydraulic trips now guard the turbines.

most cases where cracking has occurred, abnormally large rotor vibrations had been endured for some time.

One other alignment scheme appears attractive although it is not currently in widespread use on electric-utility turbines. The bearing is of a multiple-pad type, each pad being supported on a spherical button, thereby enabling it to completely align itself to the journal, Fig. 3. This type of bearing has been used on large water-wheel generators with excellent results. The fact that the bearing is of the tilting-pad type implies other properties, aside from successful support of the rotor, which can be extremely important.

Aside from the primary properties of a journal bearing which enable it to support successfully the rotor, sometimes other properties are also exhibited. Certain of these properties are harmful, others beneficial.

It has been known for some time, for example, that conventional oil-film journal bearings exert a very strong beneficial influence on the unbalance vibration of rotors, particularly at critical speeds. Only recently, however, have these properties been determined by experiment [1],[2] and put to practical use in rotor design. Their application has permitted a major increase in the accuracy of critical-speed calculations. In fact, certain by no means infrequent cases may be cited where actual critical speeds are 50 per cent or less of the critical speed calculated on the basis of conventional rigid-support assumptions. In all these cases, inclusion of bearing-oil-film properties in the calculation permits accurate prediction of the critical speeds. The results of typical calculations for various rotor sizes, using consistent design rules, are given in Fig. 4. Note the size effect whereby large rotors are more affected than small ones.

While the effect of the bearing oil films on the value of the critical speed is important, undoubtedly the most important aspect of the bearing properties is the limitation of vibration at the critical speed to relatively low values, thereby permitting operation of machines, with commercial balance or worse, above, below, or on critical speeds. By way of comparison, a turbine blade with good damping will have a vibration magnification at resonance of roughly 100 times, whereas a rotor with normal bearing damping will exhibit a magnification at resonance of roughly 5 or less. It may be seen then that only oil-film damping makes possible the flexible rotor designs used in most modern equipment.

Oil Whip

In direct contrast to these beneficial properties of journal bearings, are the properties which lead to the self-excited vibration known as oil whip [2, 3]. While oil whip has been a problem for years with high-speed machinery employing lightly loaded conventional journal bearings, only recently have events indicated a need for greater care in that regard in the design of central-station turbines. This need has been brought about by the trend toward relatively lightweight high-pressure rotors with their big journals for torque reasons, and by the large partial-admission reactions which lead to wide variations in bearing load as operating conditions change.

Oil whip is a vibration characterized by relative mo-

[2] Numbers in brackets designate References at end of paper.

Fig. 6 Thermocouples indicate the effect of oil flow on cooling efficiency. With low oil flow at 6000 rpm, the oil is heated 70 F before it ever reaches the thrust shoe

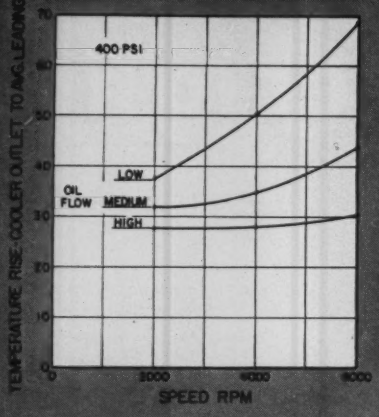
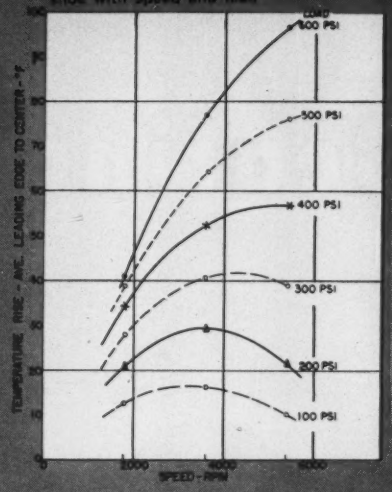


Fig. 7 The temperature rise across the shoe with speed and load



tion between the journal and bearing, the journal center moving in an area-inclosing path in the direction of journal rotation. Usually, though not always, the rotor is the major vibrating element. The frequency of vibration is invariably less than one-half journal-rotational frequency, and this is the basis of recognition of oil whip in the practical case. It is this frequency property which distinguishes oil whip from subharmonic resonance, another, more common, low-frequency vibration for which the corrective measures are in most cases approximately the opposite of those used with oil whip.

When oil whip is encountered, the usual corrective measures are to restore bearing clearance or oil viscosity to normal if either is out of line, to use a narrower bearing, or to groove the bearings, sometimes axially, but usually circumferentially. In severe cases, where these cures are marginal or inadequate, it is deemed advisable to employ the tilting-pad type of journal bearing. Whereas bearings, whose oil-film boundaries are fixed, will support oil whip at some speed despite grooving, or other special contouring, the tilting-pad type of journal bearing will not support oil whip irrespective of the speed of rotation, or the system to which it is applied [2]. They may thus be correctly catagorized as a completely stable type and have been used for some years in difficult high-speed applications. They have an excellent record, their chief disadvantage being markedly higher cost.

One usual design of tilting-pad bearing, Fig. 5, has the pads rocking on pins. If, instead of a pin, a button is used, then the antioil-whip properties are combined with an excellent alignment feature, Fig. 3.

Thrust Bearings

The level of reliability of the journal bearing has not been quite equaled by the thrust bearing. Further, the consequences of a thrust failure tend to be more serious than those of a journal-bearing failure. This has led to a development program to improve the reliability and capacity of thrust bearings, and to the use of instruments and devices to monitor and protect the thrust bearing and turbine from damage. It is felt that the low level of thrust failures in recent years is due, at least in part, to these efforts.

To protect the thrust bearing as well as the turbine, thermocouples in contact with the babbitt in the thrust shoes, and on occasion a thrust-measuring-and-recording device are used. Recently the trend has been to regard the thrust recorder as essentially an instrument which is used to verify the thrust levels in new designs.

Quite good success has been had with thermocouples in the thrust-bearing shoes. In a number of instances, dangerous situations have been pointed up in time to permit correction before failure. The location of these thermocouples is such in certain cases that an estimate of the adequacy of the oil flow may be made as well as a very rough estimate of the load the bearing is carrying. A limit of 180-F babbitt temperature at the center of the shoe still appears to be reasonable for normal operation.

To protect against the possibility that occasionally trouble might not be indicated soon enough to anticipate complete failure of the bearing and allow the machine to be shut down to prevent serious damage, a hydraulic thrust trip is now being applied to all electric-utility turbines. The device consists essentially of two nozzles at a specified distance from either side of a disk on the turbine shaft at, or near, the thrust bearing. These nozzles are supplied with oil through orifices from the high-pressure oil system, and have a pressure take-off on each side through a check valve to an alarm and a trip device. The alarm device is electrical while the trip device may be either electrical or hydraulic. These components are so designed that, as the disk approaches one of the nozzles due to wear or wiping of the thrust shoes, the nozzle-to-disk distance tends to become the limiting restriction in the oil line and takes an increasing portion of the available pressure drop, thereby increasing the pressure in the alarm-trip line. When this pressure reaches the alarm or trip setting, the appropriate action occurs. The thrust bearing will not be saved, but the generous margin between the trip setting and serious internal contact will trip the machine in time to eliminate any major damage to the machine. The device is also designed to be readily tested during turbine operation.

Bearing Research

In addition to the development of these protective devices, research and development have been carried out

Fig. 8 The variation in oil-film thickness with speed and oil flow

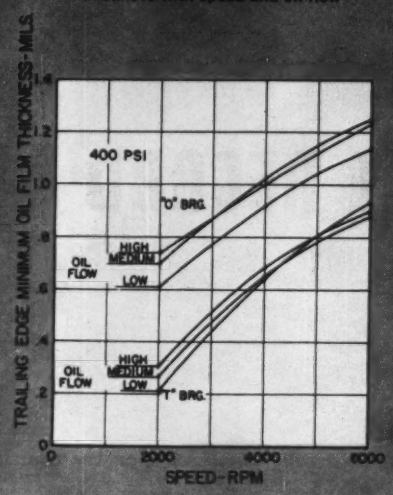
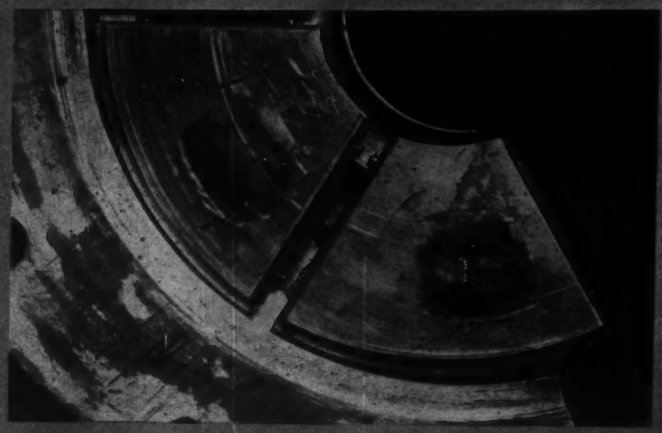


Fig. 9 The first signs of bearing distress are commonly found at or near the center of the shoe. The black deposit is burned oil.



on thrust bearings themselves. In fact, much of the information and data on the thermocouples used in thrust shoes is a direct product of these tests. Commercial designs of the 72-sq-in. bearing size can be tested in the equipment over a speed range of 1800 to 6000 rpm, a load range of 0 to 2000 psi, and oil flow ranging from 0 to 80 gpm per bearing. The bearings are suitably instrumented with thermocouples and oil-film thickness gages, and are tested two at a time by loading against each other.

The thermocouples on the leading edge of the bearing give an excellent indication of the adequacy of oil flow, while the rise in temperature across the shoe gives a rough indication of the load on the shoe. Some typical results, and one of the important lessons learned to date are shown in Fig. 6; that is, the extreme importance of sufficient oil flow for most conditions of operation. Note that, with the low oil flow at 6000 rpm, the oil is heated 70 F before it ever reaches the thrust shoe. This of course is due to the entry of hot oil from the discharge of the previous shoe without sufficient dilution by cold supply oil. A number of cases of field trouble have been cleared up through the recognition of this simple basic principle. The results obtained so far are illustrated in Fig. 7, and the variation of the temperature rise across the shoe with speed and load is indicated.

In order to obtain some data on maximum allowable size of dirt particles in lubricating systems, and an idea of the order of magnitude of collar and shoe distortions which are of practical importance, oil-film thicknesses were measured by an electrical method. Some typical results for the minimum film thickness on the trailing edge of two different shoes are given in Fig. 8. While the two shoes are at somewhat different levels, the trends are quite similar. From these data it is clear that normal film thicknesses are considerably less than a mil, hence distortions or geometrical inaccuracies of roughly $^1/_4$ mil or less are quite important in their effect on shoe load-carrying capacity. This is further attested to by the fairly common field experience of finding the first signs of distress at, or near, the center of the shoe. This result has also occurred in the tests when the load and speed were too great for the oil flow. An example of the first signs of distress is shown in Fig. 9. The black deposit is burned oil.

While the characteristics of bearings under normal operating conditions are of great interest to the designer, operation under extreme conditions is also of prime interest. In a series of ultimate-load tests, preselected speeds and oil flows are maintained while load is increased until the bearing fails. These tests differ from field operation in the essentially steady application of load, the shorter time period, and in the employment of a 10-micron filter in the test device.

Failure loads which are in the neighborhood of 1000 psi and up vary with speed and oil flow. More attention to detailed bearing design should increase these attainable failure loads appreciably.

Variables other than those normally associated with bearing operation occasionally enter into the determination of bearing life and/or reliability. One well-known example is cleanliness of the lubricant system. Another is electrical pitting of bearings which was recently experienced with a clear-cut case in an industrial machine. The individual pits are small compared to the usual scratches, and there would seem to be room for some doubt as to the deleterious effects of such pitting, particularly with a bearing whose shoes are free to tilt and assume a new inclination should wear occur in one particular area. It can hardly be argued, however, that such pitting is beneficial; consequently, a grounding brush is supplied with each new machine which does not have water glands.

In conclusion, careful bearing design will not only improve bearing reliability, but can markedly improve machine performance with respect to rotor vibrations.

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BRIEFING THE RECORD

The Next Decade

THE number of managerial, professional, and technical people—now the largest single group in the American labor force—may well double in number within the next decade. Not only do they far outnumber the hourly paid machine operators but they are also the fastest-growing group, according to an article by Peter F. Drucker, "The Next Decade in Management," portions of which are reprinted by permission from the December, 1959, issue of *Dun's Review and Modern Industry*. Copyright, 1959, by Dun & Bradstreet Publications Corporation.

"By the end of the 1960's," the author continues, "they will account for the bulk of American business wage and salary bill. And by 1970, every other young man (and every third young woman) entering the labor force for the first time will have been to college and will therefore expect to move into technical, professional, or managerial work."

One effect will be an increasing rigidity of the cost structure of business. People who do "knowledge work" enjoy, by and large, high stability of employment. Their numbers do not fluctuate with production volume, except over fairly long time periods. Whereas "labor" is still considered by accountants and economists as a variable cost, it will become increasingly a fixed cost for the businessman. Indeed, this is how personnel costs actually behaved during the recent 1957-1958 recession.

Managers will therefore have to learn new ways of cost accounting—cost accounting, for instance, in which time periods, rate of utilization of capacity, and product mix, rather than "unit costs," are the basis of costing and pricing.

Better controls will also be needed over the size of technical, professional, and managerial staffs, and of their composition to avoid inflation of these staffs during good times which will remain as unsupportable overhead when business turns down.

"Effective personnel management of the knowledge worker," Professor Drucker states, "may require as much study as has been devoted in the past 25 years to the personnel management of the manual and clerical worker."

So far, it is known what he costs, but what he contributes or should contribute cannot be measured. There is no gage of productivity for the research chemist, the wage and salary administrator, the quality-control man, the plant engineer, or division manager. Yet, clearly the productivity and results of every business and of the entire economy increasingly depend upon the contributions of these people.

The increasing tempo of innovations will also have a major effect.

Industrial research expenditures in this country now run around $5 billion a year—exclusive of defense-focused research. Thirty years ago, at the crest of the boom of the 1920's, the total industrial research budget of the country was well under $100 million. The real increase has occurred in the past five years—which means that the full impact of all this research is still ahead of us.

Above all, managers will have to learn how to manage innovation. Where should innovation efforts be directed? How extensive and intensive should they be? What risks of innovation can a business afford to take? What are the risks it cannot afford to take, and which are the risks it must take, even though the odds against success may be astronomical?

The article also contains some cogent analysis of the relation of the distribution and capital functions in relation to the future of the economy.

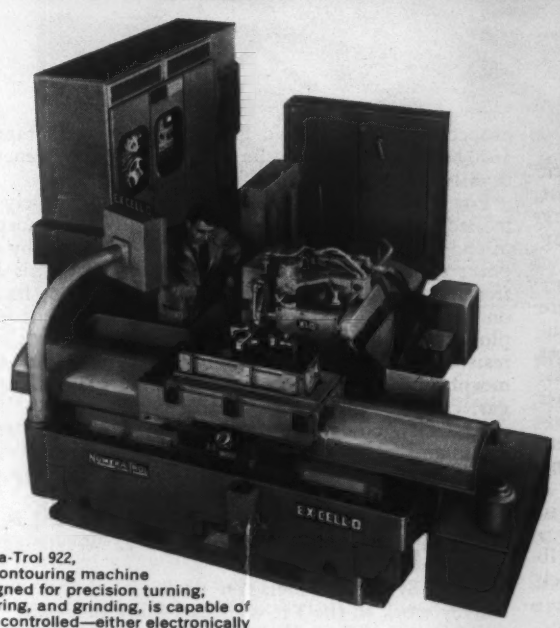
Automatic Inspection

A PORTABLE electronic device to measure production-line standards and quality control, where the standard-deviation method of measurement is used, has been developed by American Machine & Foundry Company. The AMF Standard Deviation Meter electronically counts, weighs, computes, and records the individual standard deviation of production-line items. It compares each product with its average standards and then computes the deviation from the standards. The complete measuring procedure is done in approximately one-hundredth of the time required by manual methods.

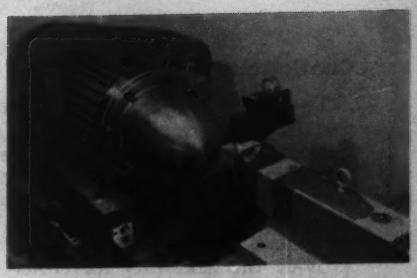
The first application will be for monitoring cigarette production. The machine will check the quality and weight standards of 2000 finished cigarettes in less than 2 min compared to the 3 or 4 hr required to inspect that quantity by hand.

It is anticipated that the new AMF machine will have application in many mass-production industries where close quality control is required, such as automatic parts, screw machine, canning, and food processing.

The output of the AMF machine can be presented on a meter scale, recorded on a chart, or printed in digital form on paper tape. The unit operates from standard electrical service and can be installed quickly by plant personnel at any location along a production line.



Numera-Trol 922, a contouring machine designed for precision turning, boring, and grinding, is capable of being controlled—either electronically or manually—in increments of 25 millionths



Custom Ex-Cell-O Turning and Boring Spindle with spherical workpiece. Infinitely variable spindle speeds are obtained through hydraulic motor.

Roller bearings on the slideways and preloaded circulating-ball-type lead-screw and nut assemblies contribute to the accuracy of Ex-Cell-O machines

Precision Contouring

NUMERA-TROL 922, a contouring machine, designed for precision turning, boring, and grinding, and capable of being controlled—either electronically or manually—in increments of 25 millionths has been introduced by Ex-Cell-O Corporation, Detroit, Mich.

The machine bed is heavier and more rigid than that in standard machine tools, while the slideways are hand scraped to surface-plate accuracy and incorporate precision roller bearings, matched to a few millionths of an inch to guarantee ease of movement and immediate, accurate response to directions from the tape control system.

Although the cross slide weighs approximately 1000 lb, it requires a pressure of only $5^1/_2$ lb to overcome inertia, and only 5 lb to maintain movement.

Parallelism of the slideways is checked by an optical flat accurate to $1^1/_2$ millionths in. and checked periodically with the U. S. Bureau of Standards.

To maintain accuracy during production operations, Numera-Trol 922 is operated under a constant temperature of 72 F. Heat from the electronic equipment is ducted away from the work area, and the hydraulic power unit is water cooled. Other features of the new machine include its building-block design, with interchangeable machine units, self-contained except for the hydraulic power unit of one of them. One unit is for turning and boring, the other for precision grinding.

Accuracy of the degree of Numera-Trol 922 has become necessary through demands of missile and rocket development. Such accuracy is not possible with manually operated machines where differences in operators and variations within the machines may cause dimensional variations in the parts produced.

In addition to extreme accuracy, Numera-Trol also combines many other benefits of numerically controlled machines, including lowered cost of short production runs, reduction of time necessary to change from one job to another, increased output, and improved quality.

In effect, the process brings the same benefits to short-run operations which automation brings to long-run jobs.

Progress on Fusion Power

WHAT progress has been made in the controlled thermonuclear field during the last year? According to John H. Williams, commissioner, U. S. Atomic Energy Commission, speaking at the Annual Meeting of the American Petroleum Institute in November, 1959: "The strides have been significant. Plasma temperatures of about 10 million K have been achieved against a previous high of about 1 million K during 1957. In terms of power which is released by those particles which do fuse (and, of course, this quantity rises as higher plasma temperatures are achieved), we have seen significant increases during the recent months, but we are a long way from reaching the 'critical' or 'ignition' energy at which the process experiences sufficient fusions to balance out the energy loss and, therefore, sustain itself."

The conversion of fusion energy into mechanical or electrical power "may well be 15 to 20 years away," Mr. Williams stated, indicating how shis might be done:

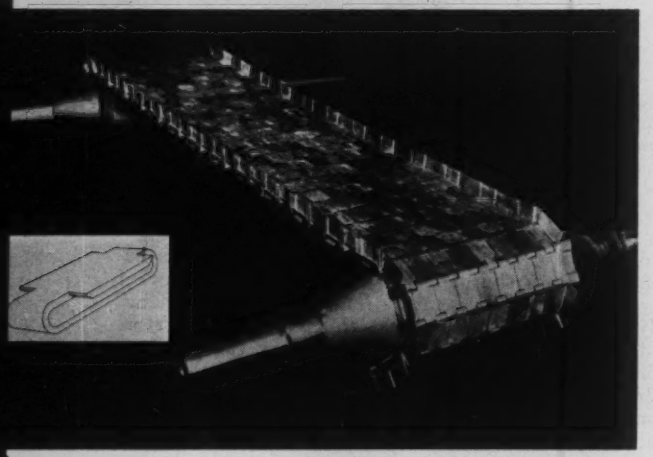
"The reactions which will be most prominent in a fusion reactor . . . produce both neutrons and positively charged protons and helium nuclei. The escaping neutrons would be utilized by trapping them in a highly absorbing material, so that the resultant reaction would produce heat which would be carried away by a suitable coolant and ultimately fed to a steam-generating system. The copious supply of neutrons available could, concurrently with the production of heat, also be utilized in producing or breeding tritium which may also be used in fusion reactions. For breeding, lithium 6 would act as the trapping medium On the other hand, because of their charge, protons and helium nuclei produced in the reactor would be trapped in the reaction volume, known as the plasma. As more energy is added to the plasma, it would expand, and the motion of the protons and helium particles could be used to produce an electric current directly in appropriately designed circuits."

Continuous Heat-Treating

Two controlled-atmosphere furnaces have recently been installed by Surface Combustion Corporation to permit a swing-over from batch to continuous-heat-treating practices at the National Screw and Manufacturing Company, Cleveland, Ohio.

Capable of handling up to 1500 lb of small parts per hr, these units described by Alloy Casting Institute provide the flexibility for either carburizing or clean-hardening heat-treating operations carried out on most of National Screw's 40,000 headed and threaded products. The high-production furnaces replace many smaller units and offer better atmosphere control and improved quality. Conveyers integrate hardening, quenching, and tempering facilities, thus reducing manual monitoring and operational and maintenance costs.

Continuous belts feed work through the furnaces in totally enclosed units where the lots are exposed to a temperature range of 1550 to 1700 F, loads of 20 to 30 lb per sq ft, highly corrosive hot gases, plus thermal shock



Heat-resistant type-HT-alloy belt links provide long life under the high temperatures of a continuous-heat-treating conveyer

encountered when the comparatively cold work is fed from a hearth onto the glowing-hot belt. Creep strength (resistance to plastic flow) and stress-to-rupture values (load-carrying capacity) are especially important. Heat-resistant type HT (Alloy Casting Institute designation for 35 per cent Ni, 15 per cent Cr) was selected for the belt link, which must provide long life under these severe operating conditions. Type HT has good retention of hot strength which is about double the strength of the comparable wrought alloy at 1600 F. Rupture strength for 100 hr is 8500 psi, and 7000 psi for 1000 hr, and operation is satisfactory at temperatures up to 1900 F.

The cast-alloy links from which the continuous belts are assembled are of a special loop-type design. Their simple shape reduces imposed stresses which are the primary cause of bending. This design also promotes maximum casting soundness and minimum shrinkage. Furnace rolls for belt support and drive and idle drums are also cast from type-HT alloy.

Endothermic generator gas or endothermic gas enriched with controlled amounts of methane gas supply furnace atmosphere, depending upon the heat-treated properties desired. Two gas generators each rated at 3600 cu ft per hr supply the furnaces, with one generator usually relegated to stand-by duty.

For parts where surface hardness must be closely controlled without producing scale, a "neutral" atmosphere of endothermic gas is used with proper control by dew-point reading. Termed "clean hardening," this heat-treating method prevents an oxide coating from forming on the work. A straight carburizing treatment is employed for special parts which require a hard, wear-resistant surface and a tough core. Here, furnace atmosphere is a mixture of endothermic gas and natural gas, carefully blended to control carbon content of the steel. Dew point is controlled at proper values depending upon the depth and hardness needed for the "case." Containing up to 2.50 per cent silicon, cast alloy HT also offers excellent resistance to carburization.

Heating is accomplished by passing natural gas, plus air to support combustion, through 12 W-type eductor radiant tubes.

Twin Syntron feeders on each continuous furnace convey work to the 3-ft-wide cast-alloy link belt. This provides for uniform distribution of the parts across the width of the belt. After passage through the furnace, parts drop from the belt through a chute and into a quench tank which can be filled either with water or oil. A continuous-flight conveyer belt removes the parts from the quench and deposits them in a tempering basket for cleaning in a soluble-oil solution. Work can then be tempered in any of ten recirculating air-draw furnaces, sized for flexibility.

During water quenching, precautions are taken to prevent water vapor from rising into the furnace and raising the dew point of the atmosphere. Here, eductor tubes are placed in the quench chute to remove water vapor and some atmosphere from the chute and to prevent contamination.

High-Temperature Laminates

Two new high-temperature industrial laminated plastics—Grade ARF-HT, an asbestos mat plastic, and Grade G3-HT, a glass-fabric plastic—have been announced by Synthane Corporation, Oaks, Pa.

Grade ARF-HT consists of an asbestos mat reinforcement with a modified phenolic resin binder and can be used at 500 F. It is available in sheets and strips and, for special requirements, in tube form.

Flexural strength (40 per cent retained after 1000 hr at 500 F) for Grade ARF-HT is 35,000 psi lengthwise and 25,000 psi crosswise. Compressive strength (90 per cent retained after 1000 hr at 500 F) is 50,000 psi flatwise, tensile (40 per cent retained, same conditions) is 20,000 lengthwise and 12,000 crosswise. All properties are as received, and before exposure.

Grade G3-HT also available in sheets and strips, and in tube form for special requirements, has a glass fabric reinforcement and a modified phenolic resin binder for a recommended temperature resistance of 500 F.

Properties include: Flexural strength, before exposure, 60,000 psi lengthwise and 50,000 psi crosswise; compressive strength is 50,000 psi flatwise; and tensile strength is 30,000 psi lengthwise and 25,000 crosswise. Percentages of the original strengths retained after 1000-hr exposure to 500 F are: Flexural strength, 40 per cent; compressive strength, 80 per cent; and tensile strength, 40 per cent.

Water is pumped to the upper pool A with off-peak power from a steam-electric plant. During the day, when demand is great, the water flows through tunnel B to generate 350,000 kw of electricity at C. Water in reservoir D impounded by dam E is used over and over.

"Pumped-Storage" Power

THE Taum Sauk Plant, a $50-million "pumped-storage" peak-power hydroelectric project, will be built near Lesterville, Mo., by Union Electric Company of St. Louis for service in 1963. Only two other large pumped-storage plants—one at Niagara Falls—are being built at the present time, and Union Electric's project will be the largest so far authorized.

The novel plant will provide an additional 350,000 kw of daytime peak capacity for the St. Louis area.

Two small pools, one on the east fork of Black River at Taum Sauk Creek, and the other on top of a granite mountain nearby which rises 1000 ft above the surrounding terrain, will be created for storage. They will be connected by a mile-long 26-ft-diam tunnel.

Combination pump-turbines using power from highly efficient St. Louis area steam plants will move the water from the lower to the upper pool each night. The water will then flow to the lower pool during daylight hours, generating 350,000 kw of electricity in the process. The project was made possible by the development in recent years of pumping equipment that becomes an electric generator when it is operated in reverse.

As explained by George P. Gamble, Mem. ASME, operating vice-president of Union Electric Company, the project does not involve a natural resource as in a conventional hydroelectric plant, since the source of the power still is the coal used to produce the electricity required in the pumping operation. The same water is used over and over again, and serves merely as a storage medium for steam-generated electricity.

Once the lower pool is full, there will be no appreciable change in the flow of the East Fork of the Black River, since the normal upstream flow will be passed on downstream through a pipe and sluiceway.

The project will require approximately 3 kwhr of night-time surplus power to pump the water required to make 2 kwhr in the daytime when it is needed. Despite this, the project will result in substantial economies. Chief among them will be the fact that utilizing idle night-time capacity will defer the starting of construction on a more costly new steam generating plant elsewhere on the system for about two years.

Plant Protection

A PLANT-PROTECTION system using electronic eyes and ears linked to an automated nerve center, demonstrated by Minneapolis-Honeywell Regulator Company, will not only "perform all the policing duties now handled by a staff of human guards in an industrial setup, but can perform them better," according to John E. Haines, Mem. ASME, company vice-president.

The system would afford 100 per cent protection for an entire building or factory operation, even if sprawled over several acres with many entrances miles apart.

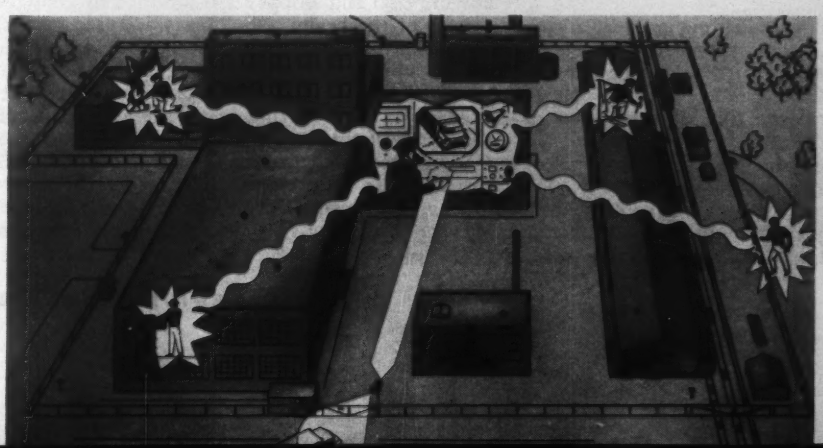
A single human guard—seated at a master control center—can: (*a*) Maintain constant surveillance; (*b*) keep an eye on all entrances by means of closed-circuit television and even converse over a two-way intercom system with anyone seeking admittance; (*c*) detect fires; (*d*) determine when any unauthorized person tries to sneak into the grounds; (*e*) detect a sneak-thief who might conceal himself in a room in the building and try to rifle a safe or file cabinet after the building is closed; (*f*) perform other policing activities.

The system is so effective, Haines said, that should the guard at the control center himself be overpowered by an intruder or collapse from illness, a built-in safeguard automatically flashes a warning to police headquarters.

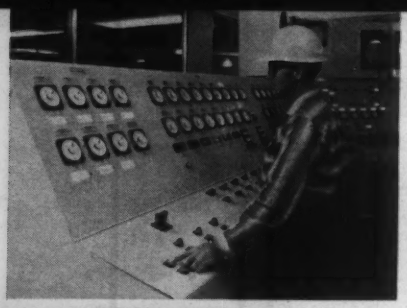
The system includes a number of new electronic developments, such as noise and motion detectors, and an electronic fence which the company says "really works." Also included are more conventional devices, such as TV cameras at entrances, magnetic switches that unlock gates from the master control center, fire detectors, and holdup-alarm switches.

While some of these devices previously have been available as separate units, Honeywell officials pointed out that the new system introduces for the first time the concept of integrating such devices under centralized control. Haines estimated that widespread use of the new system would reduce by 40 per cent the $250 million spent annually by American industry for plant protection.

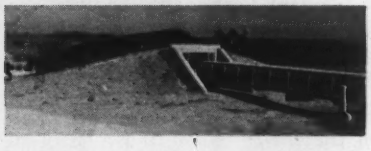
"In addition," he said, "this automated security system provides 100 per cent plant security at all times, compared with an estimated 10 per cent over-all effectiveness of a guard making his rounds in a large industrial building."



Centralized plant protection is provided by a combination of electronic devices from closed-circuit TV to various alarms and fire-detection units. Surveillance expenditures are reduced 40 per cent and the efficiency is increased by 90 per cent.



Pushing a single button starts a 5½-mile cross-country conveyer which carries 1000 tons per hr of crushed limestone over railroads and under cattle crossings. Precast, prestressed-concrete channel stringers support the conveyer and also form a cover for it.



Cross-Country Conveyer

A 5½-MILE belt-conveyer system supported on prestressed-concrete structures carries 1000 tons per hr of crushed limestone from the Lawrence, Okla., quarry of Ideal Cement Company to its $20-million cement mill at Ada, Okla.

Engineered, fabricated, and erected by Link-Belt Company, the installation consists of seven separate belt conveyers arranged consecutively to feed onto each other. The system changes direction four times, and forms a giant letter S.

The conveyer crosses two highways and the Frisco and Santa Fe Railroads, and provision has been made at numerous points for passage of cattle and farm equipment.

The longest conveyer, almost 2¼ miles in length, required an endless rubber belt 4½ miles long. Although it travels at 500 fpm it makes only 10 round trips during an 8 hr day. By contrast, the shortest flight is 550 ft long.

The conveyer carries limestone crushed to ¾-in. size four days a week and shale on one day.

A single push button starts the entire system, using a sequence of relays to start each succeeding section after the tail pulley of the preceding section has reached about 50 per cent of normal operating speed. This starting sequence takes about 5 min when the system is fully loaded.

Every conceivable condition of loading has been anticipated to insure adequate starting power and to control the tremendous inertial forces which would be released in the event of power failure.

Dynamic braking shortens the time of coast-down or provides inertia in the form of flywheels to extend the time of coast-down in case of a power failure. Safety devices include interlocking and automatic control.

In a radical departure from steel-supported conveyers, the belts are supported by precast, prestressed-concrete channel stringers spanning 50 ft. In the final raised conveyer which crosses the Frisco Railroad, 97-ft prestressed-concrete girders rest on 30-ft-high four-legged towers. In addition to supporting the conveyer, the stringers form a cover over the top of the belt. One side of the conveyer is curtained by a continuous corrugated-aluminum wind guard. The stringers rest on precast reinforced-concrete U-stands.

The entire system is on a fenced right-of-way strip which averages 100 ft in width, and contains a 40 ft-wide earth roadbed with its drainage structures, an electrical power-transmission line from mill to quarry, the belt-conveyer structures, and a 16 ft-wide stone-surfaced road for inspection and vehicle access.

Checking Coal Stoppages

BOILER-COAL-FEED lines are continuously monitored for stoppages at Columbus & Southern Ohio Electric Company's Conesville Generating Station near Coshocton, Ohio, with gamma-radiation sources and detectors.

As described in the November 1, 1959, issue of *Electric Light and Power*, the AccuRay devices manufactured by Industrial Nucleonics Corporation scan the progress of coal through the pipes by passing gamma radiation through both walls of the standpipe and its contents. No moving parts are involved. A clear differentiation between flowing coal and stoppages is afforded by changes in intensity of the beam. Two units are used on each pipe since coal may bridge and stop flowing at any position.

An audiovisual "no-coal" signal is operated in the control room whenever the pipe is empty at either position. The operator then starts the vibrator to dislodge the coal. If this is not successful before the second detector senses no coal, the feed will trip automatically by stopping the coal-feed motor, closing the gate to the firebox, and closing the air damper to the cyclone.

Long half-life of the radiation sources insures reliable operation for years.

"Dial 'D' for Democracy"

A "POLITICIAN-FRIGHTENING" device which would take a poll of public opinion on any issue in a matter of a few hours is described in the October 23, 1959, issue of the British journal *Engineering*.

Headed "dial 'D' for democracy," the article reports a system developed by Vladimir K. Zworykin, director of the medical electronics center of the Rockefeller Institute of Medical Research in New York, which would enable every citizen with a telephone, or access to a phone booth, to vote on any issue being put before him.

Dr. Zworykin described the system at the Cavendish Laboratory, Cambridge, as part of the fourth Clerk Maxwell memorial lecture, "The Human Aspect of Engineering Progress," which he delivered during the convention of the British Institution of Radio Engineers.

Every telephone would be equipped with a tele-voter box and each voter would be issued a voting card. When this was inserted into the box, either a "yes" or a "no" button could be pressed. After the poll, the boxes would be interrogated rapidly by sending microsecond pulses over the phone wires, which would not interfere with the use of the telephone for conversations. The voting mechanism could also be cleared for the next issue at the same time. Computer equipment at the telephone exchange would announce the results very quickly.

"Economatic" Transfer Machines

TRANSFER machines are commonly thought of as performing only related operations. An Economatic transfer machine, designed and built with standard components by Buhr Machine Tool Company, Ann Arbor, Mich., demonstrates, however, that many types of operations can be combined effectively.

Installed at the Saginaw Steering Gear Division, General Motors Corporation, Saginaw, Mich., this 76-station closed-loop palletized transfer machine includes drilling, reaming, tapping, recessing, face milling, wire bushing, surface generation, precision boring, and assembly among its 220 operations. In addition, each power-steering pump housing is automatically gaged and marked so that it can be selectively assembled with mating components.

Two hydraulic pump housings are manually loaded and then automatically located and clamped in each fixture-pallet. Parts are finished at the rate of 300 per hr at 100 per cent efficiency.

Various surfaces are milled and some holes are drilled, reamed, spot-faced, counterbored, chamfered, and tapped. Near the end of the first 117-ft-long leg of the machine, a babbit bushing is correctly oriented with respect to the pump-shaft hole and is then pressed home. ID's of these bushings are precision bored after assembly.

The versatility of this type of transfer machine makes it possible, for example, to eliminate a subsequent burnishing operation and add a new operation formerly done separately. The added operation is for ballizing a hole to size to required surface finish.

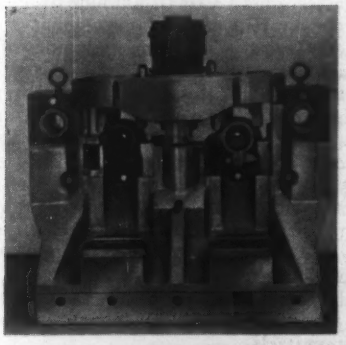
Another example of process freedom is found at the face-milling station. The face mill is hydraulically fed in to the pump housing and mills on an upward feed stroke of the cutter. Change gears have been included in these heads so that right feed and cutting speed may be paired for optimum cutter life. The ability to vary the spindle speed provides flexibility for workpiece material changes in the future.

The precision-boring operations require almost twice as much time as any other machining operation on this 24-sec-cycle machine. Rather than double the cycle time, pallets are accumulated, then indexed two at a time through the two precision-boring stations.

Automatic in-process checking is done at various stations by 12 probes to make certain that holes have been drilled, and 13 drill checks to monitor other drills.

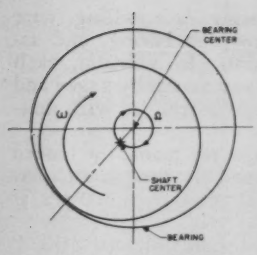
In addition to automatic classification, roving inspectors occasionally check partially finished workpieces when the pallet fixtures are in idle stations. With dial-indicator gages, they can check housing from both sides of the line. Gage-locating steps and buttons are included in the palletized fixture to reduce the time required for these inspections.

Spherically mounted "crow's-feet" and a pivoted clamp permit full equalization of clamping forces

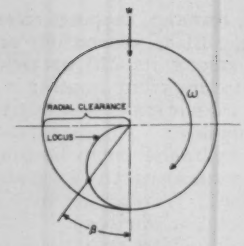


Front view of the pump housing produced on the 76-station machine. The babbitt bushing has to be correctly oriented before it is pressed into part.

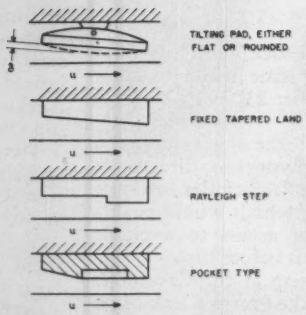
A 76-station Buhr Economatic combines machining, assembly, and inspection operations for power-steering pump housings, shown left in profile



Orbital whirling



Locus of motion



Types of gas-lubricated bearings

Spiral-grooved and herringbone thrust plates

Gas-Lubricated Bearings

GAS-LUBRICATED bearings have been coming into increasing prominence for a number of applications. Their simplicity, quietness, reliability, low friction, and ability to operate at extremes of temperature and speed, the absence of contamination, and long life have made them of general interest.

What they are, why they are of interest, areas of application, and some of their behavior characteristics are outlined in a paper by Dudley D. Fuller, Mem. ASME, "General Review of Gas Bearings," that opened the recent Symposium on Gas Lubricated Bearings, sponsored by the Office of Naval Research in co-operation with nine other government agencies (MECHANICAL ENGINEERING, November, 1959, pp. 112–113.) The paper and a complete bibliography containing abstracts of 290 items that have appeared in the literature, prepared by Eugene B. Sciulli, will be included in the published proceedings of the symposium held in Washington, D. C., October 26–28, and conducted for the ONR by The Franklin Institute.

Professor Fuller defines a gas-lubricated bearing as that type of bearing which has its rubbing surfaces completely separated by a film of gas. Even when load is applied to the bearing surfaces, the surfaces are kept out of contact by this gas-film cushion. As with liquid-lubricated, fluid-film bearings, the gas film is established by either of two basic actions.

Hydrodynamic Bearing. In the first type, where self-contained bearings operate in an open bath of gas, the relative motion of the sliding parts themselves generates a film pressure within the clearance spaces of the bearing and insures both separation of the surfaces and load-carrying capacity. This type is called the hydrodynamic or self-acting gas bearing.

Since the viscosity of a gas is relatively low, at room temperature about 1/50 of that of water or 1/3500 of that of an SAE-10 petroleum oil, the load-carrying capacity resulting from this self-generated pressure is likewise relatively low. If the bearing has to start from rest under a static load and lift itself off the "ground," so to speak, and become gas-borne, unit loads are generally limited to 1 to 2 psi based on the projected area of the bearing. If the load is applied after rotation has been established, the unit load-carrying capacity may reach a practical maximum of about 10 psi, again based on the projected area of the bearing, although higher values (26.5 psi in one case) have been achieved.

Hydrostatic Bearing. With the second basic type of bearing, the externally pressurized or hydrostatic bearing, this limitation on load-carrying capacity no longer exists. Gas is supplied to the clearance space in the bearing and the surfaces are forced apart as a result. Limits on load-carrying capacity depend only on the practical limits of gas pressure and gas volume that are conveniently available. Unit load-carrying capacities as high as 50 psi have been achieved although there is no reason why this figure cannot be exceeded if necessary.

One of the conditions for successful operation of the externally pressurized bearing is that the volume of gas which flows from the high-pressure source to the lower ambient pressure must be constantly supplied. In some applications where relatively high static loads are involved, hydrostatic gas may be used only for starting. After normal operating conditions have been established the bearing may then continue to operate as a self-acting bearing.

Advantages of Gas-Lubricated Bearings. Gas bearings, either externally pressurized or self-acting, appear to have very special advantages over liquid-lubricated bearings. One is the stability of gases over a wide range of operating temperatures and suitability particularly for extremely high or very low temperatures, since gases do not undergo changes of phase, such as other lubricants, which melt, freeze, vaporize, burn, or decompose. Applications are being contemplated from about −450 F to something as high as 3000 F. Gases show small increases in viscosity as the temperature rises, which are especially favorable for high-temperature operation.

Another noteworthy advantage of the use of gas-lubricated bearings is the avoidance of contamination of the surrounding environment. This is especially important in processes where a small amount of leakage or seepage into the system from conventional li uid lubricants might well poison the entire contents of the system, as in machinery for nuclear developments.

Gas-lubricated bearings are also characterized by very low friction. This may be especially important in a number of instrument applications such as gyroscopes and similar devices. Also because of this advantage of low friction, high operating speeds become practical. Low friction means very low heat generation within the bearing so that limits on high-speed operation are not established by the ability to cool the bearing as with more conventional bearings and lubricants. These limits are established rather by such things as mechanical strength against bursting or dynamic behavior characteristics of the system itself.

One high-speed turbocompressor unit has been operated experimentally at 165,000 rpm, while another for a small turbine has been reported running at 350,000 rpm, and development work is under way for a small high-speed grinder to operate between 400,000 and 500,000 rpm.

Areas of Application. Present applications of gas-lubricated bearings include precision grinders, turbo expanders, gas circulators, experimental rotors for closed-

cycle gas turbines, air-cycle refrigeration machines, precision measuring instruments, gyros and similar devices, elements of computing machines, memory storage drums, jigs, tools, fixtures, and so forth. Auxiliary-power units based on small high-speed rotor operation may be a potential application.

Operating Characteristics. Most of the complications that arise in the analysis and application of gas-lubricated bearings stem from two factors, the compressibility of the gas and the low damping characteristics of the gas film.

Load-carrying capacity can be expressed as a function of the "compressibility bearing parameter," which takes into account absolute viscosity, surface velocity, radius (in a journal bearing)—length of pad (in a thrust bearing), radial clearance or minimum film thickness, and ambient pressure. This parameter defines the state of operation in a fashion similar to the Sommerfeld variable for incompressible lubricants.

The extent to which a journal-bearing shaft moves to an eccentric position within the bearing clearance is important.

Ambient pressure enters into the load-carrying capacity of a self-acting gas bearing since the bearing acts as a pump and, like all pumps, its pressure ratio (supply pressure to discharge pressure) is limited. A reduced ambient pressure and density around the bearing will result in a lower maximum pressure in the film and hence less load-carrying capacity.

Speed is also a factor. Although load capacity increases with speed, the rate of increase falls off at high speed due to compressibility effects and approaches a limiting value. This is unlike liquid lubricants where load capacity rises directly as speed increases, considering a constant viscosity. At extreme speeds the load-carrying capacity becomes independent of viscosity and speed and is only a function of the ambient pressure surrounding the bearing.

Instabilities. Because of the low damping characteristics of gas films, certain dynamic instabilities need to be anticipated and controlled which might have been suppressed or passed unnoticed with liquid lubricants where the damping action is greater.

Rotors supported by gas bearings must be carefully analyzed for all possible modes and types of vibration. As many as ten different "critical speeds" and instabilities had to be analyzed in one case. The spring constant of the gas film, a phenomenon known as conical shaft whirl, and half-frequency whirl, in which the center of the shaft orbits around the center of the bearing at approximately half of the rotational velocity, are a few of the problems encountered.

The threshold of whirl instability can be raised in journal bearings by the use of axial grooves, tilting pads, or a series of tapered lands or Rayleigh steps. Similar types of self-acting thrust bearings may be used. The choice of type will depend upon the relative ease of physical construction, practicality of installation in the given machine, and ability to carry the loads within the limits of available space. The tilting-pad, for example, is self-aligning but does not equalize the loads on each shoe of the bearing unless such a mechanism is included. The other types are not self-aligning and usually require some type of gimbal or pivoted mounting.

Pivoted-pad shoes used in self-acting thrust bearings have a number of instabilities of their own. Decrease in film thickness as load increases may cause a flat shoe to become parallel to the runner and the bearing becomes unable to support a load and collapses. A crowned shoe will not exhibit this tendency. Pitching, rolling, and vertical bounce are other forms of shoe instability, and all of these modes of action require investigation if the application is to be completely successful.

Potential of Hydrostatic Bearing. The externally pressurized or hydrostatic journal or thrust bearing, in general, is considered by many to be a very promising type. The load-carrying capacity has no inherent theoretical limitation since the pressurized gas is fed to the bearing and load-carrying capacity is not dependent upon the relative motion of the bearing surfaces. The practical limitations concern availability of the gas at a suitable pressure and consideration of the elastic deformation of the bearing elements themselves, but basically the load-supporting capacity can be made relatively high.

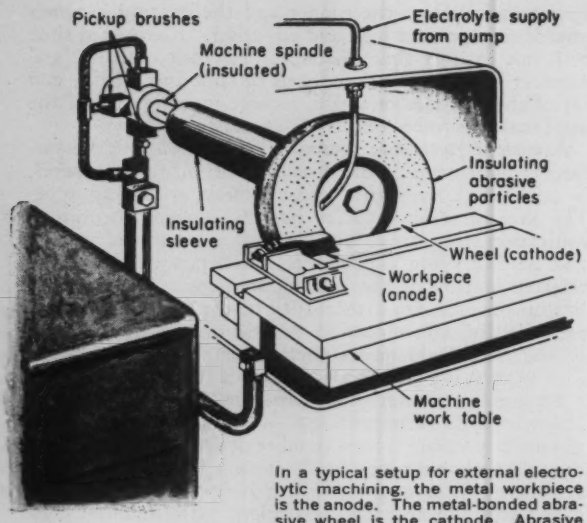
Externally pressurized journal bearings of the "inherently orifice-compensated" type are supplied with gas under pressure from a number of drilled holes around the circumference of the bearing. Gas entering the bearing experiences a throttling or drop in pressure as it passes through the annular orifices. The reduced pressure then drops off to ambient as the gas flows axially through the resistance formed by the bearing clearance space itself. At no load, when the shaft is centered in the bearing, and the eccentricity ratio is zero, the pressure forces are symmetrical all around the circumference with no resultant net force on the shaft. However, if the shaft is displaced radially, toward one of the inlet holes, the clearance on that side will decrease, the resistance to flow through the bearing clearance will rise, causing a reduction in flow. As a result of the reduced flow, the gas will experience a smaller pressure loss as it passes through the annular "orifice" so that the general pressure level will rise on that side of the bearing where the film thickness has been reduced.

A similar situation in reverse occurs on the opposite side of the bearing until the net result of these pressures and the forces they produce is to tend to bring the shaft back to its equilibrium central position and thus carry load.

"Micro-Aerodynamics." The general phenomenon of flow through slots, channels, orifices, and restrictors with very small gaps needs a thorough investigation since the physical action is so complex and yet at the same time is so basic to a thorough understanding and quantitative evaluation of externally pressurized bearings of all types. This might indeed be called the study of micro-aerodynamics as it has been so termed by Captain W. T. Sawyer, USN.

"Air Hammer." Probably every investigator who has had experience with the simple type of hydrostatic thrust bearing will testify to the instability that can easily occur. This pneumatic instability, or air hammer, appears to be a function of film thickness, supply pressure, size and depth of recess, and other variables. Frequently this type of instability can be a dominating characteristic of these bearings and, if not controlled, will prevent successful application. The usual remedy is to reduce the volume of the recess cavities in these bearings. Air-storage capacity of the bearing should be held to a minimum.

Many significant applications of gas-lubricated bearings are now being made and even more are forecast for the future, both for use in the national defense and in areas of industrial activity.



In a typical setup for external electrolytic machining, the metal workpiece is the anode. The metal-bonded abrasive wheel is the cathode. Abrasive particles projecting from the wheel prevent short circuiting. A conductive water-base electrolyte flowing across the surface of the wheel passes the current between the electrode and the wheel.

Electrolytic Machining

THE principle that causes metal to be plated at the cathode when two metal poles are placed in a conductive electrolyte bath and energized by a direct current is widely used. The fact that metal is deplated from the anode has not been used for industrial metal working until recently.

The process, which should not be confused with electrodischarge or spark-arc machining methods (MECHANICAL ENGINEERING, October, 1959, p. 82) is described in an article by Lynn A. Williams, president, Anocut Engineering Company, Chicago, Ill., in the December, 1959, *The Tool Engineer*.

Michael Faraday established not only the basic idea of electrolysis, but also the rule that the amount of metal deposited on the cathode or deplated from the anode is directly proportional to the current used in electrolytic action on the metals. So basic is this idea that the ampere is defined by reference to it—an ampere being the amount of current which in 1 sec will deposit (or deplate) 0.001118 gram of silver. This number is called the electrochemical equivalent of silver.

Every other metal has its own electrochemical equivalent; that is, for a given current a fixed quantity of metal will be removed. This is usually expressed in grams per ampere, but for engineering purposes, cu in. per 1000 amp is more convenient and is the basis of the accompanying table.

The values given are the theoretical maxima which cannot be achieved in practice. Since the electrochemical removal rates of many common alloying metals—chromium, cobalt, iron, molybdenum, nickel, tungsten—are closely bracketed, the variations among different alloys can be neglected in computing approximate electrolytic removal rates, despite the fact that the mechanical properties of the alloys may be quite different when various kinds and amounts of alloying material are used.

Electrochemical Equivalents of Industrial Metals

Work material	Removal rate[a]	Work material	Removal rate[a]
Aluminum	0.128	Molybdenum	0.119
Beryllium	0.094	Nickel	0.125
Chromium	0.137	Tantalum	0.103
Cobalt	0.125	Titanium	0.133
Columbium	0.205	Tungsten	0.121
Copper	0.134	Zirconium	0.133
Iron	0.134		

[a] Cu in. of metal removed per 1000 amp min.

The current efficiency of the process is remarkably high, however, ranging from about 75 to over 90 per cent of the theoretical, depending on the material, the electrolyte, and the work configuration. These values are much higher than those for many electroplating baths.

As a practical matter, it is usually safe to assume a removal rate of 0.100 cu in. per min for each 1000 amp of current. Although this rate applies to most steels and superalloys the value may drop to as low as 0.060 cu in. per min for each 1000 amp for some of the "straight" carbides with low cobalt content.

Since current density is determined by the manufacturer, there is little that the user can do about it except to arrange the work to present the largest possible contact area. This requires considerable ingenuity and the setting aside of many habits of thinking associated with conventional machining.

There are upper limits on the maximum attainable current density. At too high a voltage, the electrolyte breaks down and may cause arcing or may simply use up current in decomposing the electrolyte. Careful voltage control is important. Usable levels now range from 1000 to 3000 amp per sq in. of work area and laboratory densities above 6000 amp have been achieved.

In electrolytic machining little heat is generated and no problems of work damage arise. There is so little wheel wear that thousands of pieces may be made without measurable change in flatness.

On most materials, finishes of 30 to 40 microin. are readily obtainable. Optimum finishes are obtained at maximum removal rates. The smallest size holes that can be machined are 0.050 in. in diam or slot width.

With electrodes of appropriate shape, virtually any cavity configuration can be machined—round, hexagonal, slotted, even a typical airfoil configuration.

While the process could possibly be used for die sinking, it is felt that its major field of application for the immediate future will be in performing work that cannot be accomplished by other processes. "Drilling" of holes—at comparatively high rates of speed—in the superalloys and tungsten carbides is one example. The ability to machine extremely hard materials at economic speeds should enable product designers to utilize these materials much more effectively in the future. They are no longer a machining problem.

Earthquake-Proof Reactor

THE General Electric Company Limited of England has recently received a contract from the Japan Atomic Power Company for the building of a 150-mw gas-cooled nuclear power station at Tokai-Mura, about 70 miles from Tokyo. As described in GEC's September, 1959, *Atomic Energy Review*, the basic design will be similar to

the gas-cooled reactors built in Britain by the GEC Simon-Carves group.

An essential of the structural design was insuring the integrity of the reactor building and its associated steam-generating plant as a complete unit, so that no break could occur in the gas circuits during an earthquake. To achieve this, the concrete substructures supporting the steam-generating units are therefore carried on the main reactor foundation raft to insure uniformity of movement during earthquakes. In addition, the support system for the gas ducts connecting the reactor pressure vessel to the steam-generating units has been designed so that the stresses in the ducts and in their junctions with the pressure vessel are maintained at safe levels under all circumstances.

As a further measure to insure the safety of the reactor, the reactor building itself houses all the plant necessary to guarantee the removal of all heat generated within the core after shutdown, even if severe earthquake shocks should cause the fracture of all pipe connections between the reactor building and the turbine building.

Other earthquake-proofing features are found in the core where an "egg-box" type of steel-grid construction is used to hold the graphite blocks in place and to form a framework which encircles the whole core and would hold it accurately in position even during a severe earthquake. Special restraints are placed on the pressure-vessel structure. Top charging rather than bottom charging and discharging was used, to lower the center of gravity of the reactor building and improve its stability. In addition to the normal control rods, a completely independent emergency-shutdown system for severe earthquakes would drop thousands of boron-steel balls into special channels in the reactor when released by trips activated by seismic signals.

Frozen-Wall Excavation

An artificially frozen column of marshy soil, 123 ft deep and more than 40 ft in diam, is being used to sink a vertical shaft on the banks of the East River in New York City.

After striking bed rock at 123 ft, the shaft will continue down and under the river to Brooklyn as part of the Newtown Creek Pollution Project of the City's Division of Sewage Disposal, Department of Public Works.

This first use of the ground-freezing method in the East was dictated by the need to avoid any lowering of the water table or movement of subsurface formations that could endanger the foundations of the nearby buildings.

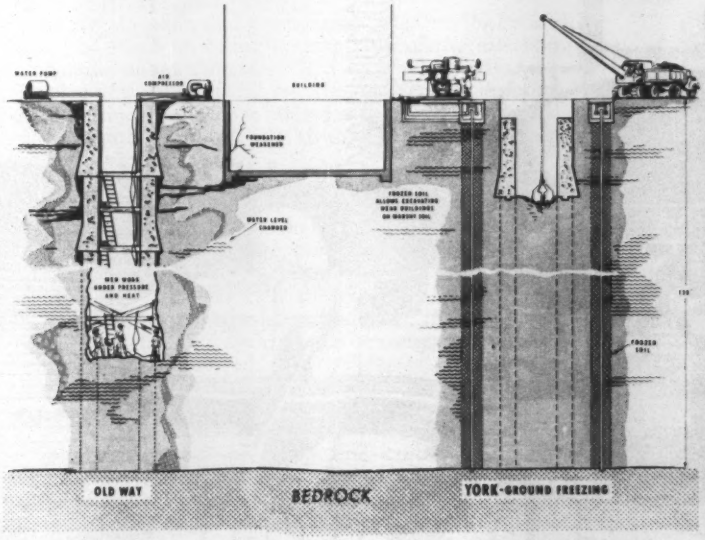
A number of side benefits of the refrigeration process have been reported and working conditions are termed far superior to those in many deep shafts constructed by other methods. The two packaged York refrigeration systems, useful for freezing skating rinks, can also be resold after the job is completed.

Two 55-ton reciprocating ammonia brine chillers, supplied and installed by the York Division of Borg-Warner Corporation, York, Pa., supply 17-F brine to 21 pipes arranged in a $26^{1}/_{2}$-ft-diam circle. The 6-in. closed-end pipes are arranged approximately 4 ft apart and contain 2-in. open-end center pipes which direct the brine to the bottom of the larger pipe. It is then returned up the larger pipes and through the return manifold to the cooler.

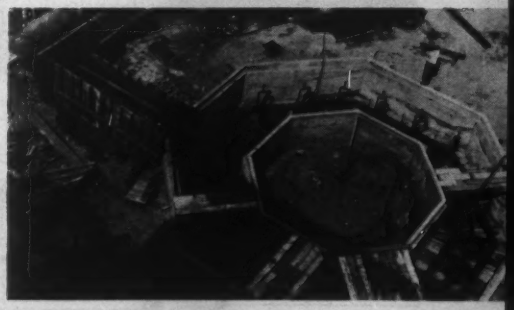
Thermocouples at the inlet and outlet of each freeze pipe give accurate readings and permit control of temperature to insure even freezing and uniform closure of the frozen "doughnut" which provides a frozen wall within which the shaft can be excavated in free air.

An extra pipe, not connected to the refrigeration system, and with thermocouples every 10 feet, is in the center of the circle to give temperature readings in that area and provide a relief as pressure builds up in the center of the frozen core.

The ice wall was established in 52 days, but as a precaution, freezing was continued for a total of 80 days before excavation began. Although no empirical formula has been developed to express how long it would take to establish an ice barrier or how far it extends, reliable techniques have been developed for determining when the ice barrier is of sufficient strength to permit excavation.



Ordinary excavation changes the water table and may weaken the foundations of nearby buildings



A circular frozen retaining wall of earth surrounds the area to be excavated and prevents disturbance of the surrounding water table

Tidal Power Turbines

LITTLE has been heard recently about the generation of power from the tides, but renewed interest is indicated by Pierre Danel, Assoc. Mem. ASME, president, Société Grenoblois d'Études et d'Applications Hydrauliques, Grenoble, France. An abridged version of his James Clayton Lecture, "The Hydraulic Turbine in Evolution," delivered before The Institution of Mechanical Engineers in London, appears in the November, 1959, issue of *The Chartered Mechanical Engineer*.

The advent and progress on the development of Bulb turbines (also called Tube turbines) have reopened the field of tidal power generation. The Bulb turbine was initially designed as a small unit to be set within a pressure pipe with a small generator in a bulb surrounded by the flowing water. These small units were inefficient.

Modern Bulb Turbine. The modern Bulb unit is no longer in a long pipe, and the water passages are kept as short as possible to reduce friction losses. After a short converging section at the inlet comes the bulb containing the generator, then the adjustable-blade runner, and lastly a well-designed draft tube.

The generator may run in oil for small units, in compressed air in larger units, or even in air at atmospheric pressure in some of the largest units.

On some low-head power plants, the total economy on both machinery and civil engineering with Bulb units may amount to as much as 40 per cent as compared to the cost of the conventional Kaplan power plant.

To be efficient, tidal power requires units which can be operated both ways as turbines and preferably also both ways as pumps. The Bulb unit lends itself very well to such a difficult type of operation, and in various parts of the world tidal power plants are being contemplated, taking advantage of the new possibilities of these machines.

A tidal power turbine has been designed for the Rance estuary project and a full-scale unit will be tested at Saint-Malo nearby. The runner diameter is 5.80 meters. The rated horsepower is 9000 kw at a 5-meter head. The Rance power plant will in all likelihood incorporate 40 such units.

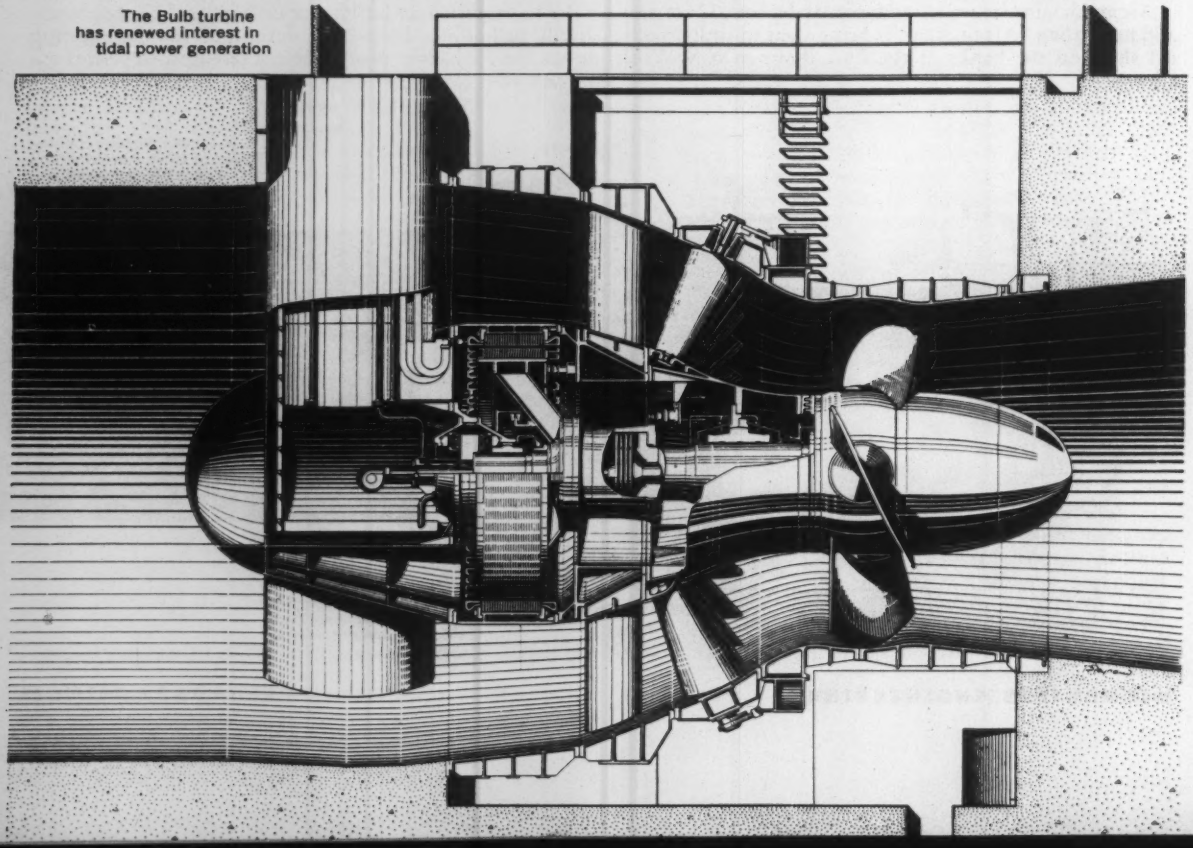
Tidal Cycles. The new possibilities offered by Bulb units for tidal power plants have encouraged a closer study of tidal power possibilities and many new cycles have been investigated. In actual fact, tidal-power-plant calculations are very complicated, as variations in turbine efficiency, alternator power limitations, the best choice of starting and finishing conditions, and so forth, have to be considered.

Currently the only approach to the problem is the use of electronic calculating machines, even if the utmost use is made of existing theory to guide the machine to the best result for any given tidal cycle and any desired cycle of power production. Of course, in practice, a succession of such cycles should be examined. For instance, a plant required for peak-load production must follow a solar cycle of output, whereas tides of course follow a lunar one. Hence, from day to day there is a change of phase. These calculations have not only shown that much more power could be developed than expected in the past but also that the power could be delivered to the grid with much more flexibility than was considered to be the case some years ago. For instance, the Rance power plant could be operated for peak-load production.

New improved tidal cycles also have a direct bearing on the design of the hydraulic turbines to be used.

In a one-way simple tidal cycle the reservoir is gradually filled through gates during the rise of the tide. The gates are then closed at high tide, and when the tide has gone down sufficiently the reservoir is emptied through the turbines.

With this simple operation the maximum energy could be developed by waiting almost for low tide before



The Bulb turbine has renewed interest in tidal power generation

emptying the reservoir through the turbines. This energy would then be developed in a very short time and the power plant would stay idle for the rest of the cycle. This, of course, is unpractical and uneconomic but can be taken as a yardstick of comparison for the energy developed by other cycles or modes of operation. This maximum energy E has sometimes been called the "wild energy" of the tide.

With the same simple operation of the reservoir, if a more even production of power is required with a smaller number of units, it will be necessary to start the turbines long before low tides so as to deliver power continuously for several hours. Instead of taking advantage of the maximum tide range, the units will then operate at a somewhat smaller head, perhaps only equal to half the tide range. Economic studies show then that the energy produced will be of the order of $^1/_2E$.

Two-Way Operation. Now, taking advantage of the fact that Bulb units can be operated as turbines with the water flowing either way, the same power plant could be used in filling the reservoir through the turbines, thereby producing more power. In such a cycle the so-called wild energy would be of the order of $1.8E$ according to local conditions, and the economic design and operation of the plant would give an energy of the order of $0.9E$.

It may look surprising at first that in operating the units both ways, with efficiencies of the same order the energy is not just doubled. It should, however, be borne in mind that the reservoir changes in area with height and this implies quite different volumes of water for the various operations.

If advantage is taken of the fact that Bulb units can be operated either way as a pump, an improved cycle can be devised.

When the reservoir is full, at high tide, more water can be pumped into it against a small head. This added water will later be passed through the turbines under a much greater head. This supposes that some energy can be drawn from the grid for pumping, the energy given back later being many times greater.

When the reservoir is emptied at low tide it can eventually be lowered further still by pumping so that more energy could be developed later when filling again through the turbines.

At certain phases of operations, gates would be used either to speed up filling or emptying of the reservoir.

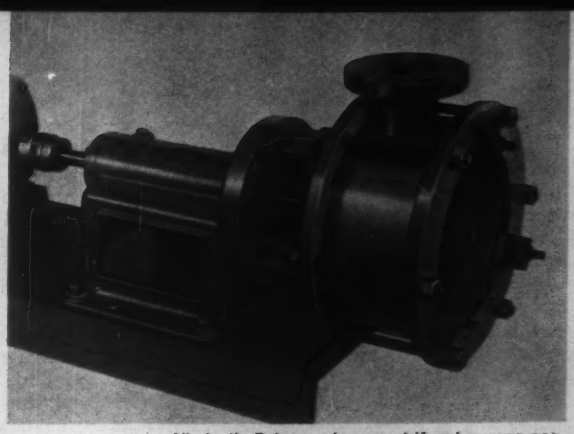
Maximum Energy Utilization. In a cycle where advantage is taken of pumping facilities, the total energy economically produced, once that taken for pumping is deducted, may amount to as much as $1.2E$ according to local topography of the reservoir.

This shows how important it is for tidal power units to be able to operate either way as pumps. These considerations reflect of course on many details in the design.

These are not ordinary pumps either. They start operation against a zero head and are used only for very small heads. In that case the conventional efficiency coefficient loses its significance and the total pumping energy used during a cycle has to be compared with the volume of water pumped.

All-Plastic Pumps

Two ALL-PLASTIC polypropylene centrifugal pumps which possess excellent resistance to solvents, greases, oils, and many common acids and chemicals at high temperature, have been added to the Vanton Pump and Equipment Corporation line of fluid-handling products.



All-plastic Polypropylene centrifugal pumps possess excellent resistance to solvents, greases, oils, and many acids at high temperatures

Available in two sizes, these pumps offer a capacity range of from 2 to 80 gpm. Pump model #ZP-25 has a 2 to 30-gpm capacity, and pump model #ZP-35 an 8 to 80-gpm capacity. Pumps can handle solution temperatures up to 300 F.

The light-weight, high-strength, rigid, mar-resistant polypropylene casing is totally protected by a cast-iron frame which gives added support. The molded impellers are of a dynamically balanced design. All polypropylene centrifugals are equipped with mechanical shaft seals of the latest design in a range of materials to cover virtually all corrosive applications.

Pumped fluid contacts only the facings of rotating and stationary rings which can be provided in either Teflon, carbon, ceramic, or Stellite material. Stationary rings can be reversed for additional use after long service.

Easy maintenance is another feature of these new pumps. By removing six bolts, casings may be inspected or replaced without disassembly of the whole pump. The heavy-duty stainless-steel shaft with a polypropylene cover on the wetted end can be removed from the pump in either direction. No special tools are required to disassemble the pump which does not have to be removed from base and motor.

Low-friction, widely spaced roller bearings are used in the bearing pedestal to give quiet operation and to reduce loading.

Plasma-Accelerator Propulsion

A LABORATORY model of a plasma accelerator has been developed by Lockheed Missiles and Space Division which has achieved propellant velocities of 200,000 mph.

Called the "collinear electrode plasma accelerator," the device, which heats a small amount of material thousands of degrees with a massive jolt of electricity, is designed to be used after a spacecraft has been boosted into space by a conventional rocket.

When fired only once a second the Lockheed device produces a thrust of more than two grams. Even at this low rate of firing, the plasma accelerator produces specific thrusts exceeding better known ionic systems.

At a firing rate of 500 pulses a second, a plasma drive weighing only a few hundred pounds could produce a thrust of about 2 lb.

Although this may sound insignificant when compared with the 300,000-lb thrusts generated by an ICBM engine, it would be enough to propel a multiton space vehicle on an interplanetary voyage once it was boosted beyond the earth's gravitational pull by a chemical rocket.

A 1-ft section of a large granite pier is burnt off with an Oxweld Stone-Shaping Torch to provide clearance for a new roadway in remodeling the Queensborough Bridge

Materials Briefs

▶ Stone Carved With Welding Torch

LARGE granite sections used in remodeling the Queensborough Bridge are being cut with an Oxweld FSJ-S Stone-Shaping Torch. The 37-in-long 7-lb torch made by the Linde Company, Division of Union Carbide Corporation, produces a 5550-F flame which carves and shapes stone five times faster than mechanical methods, according to the company.

▶ Field Cutting Possible With Glasteel Pipe

Field cutting to required lengths is now possible with a new Glasteel pipe (glass inside, steel outside) made by the Pfaudler Division of Pfaudler Permutit Inc. The product also has more than twice the glass thickness of previous glass-lined pipes and is priced lower than conventional types. It can be cut easily to fit and threaded by plant-maintenance crews. A small fire-polishing furnace and threading dies are required.

Rated at 150 psi and available in $1^1/_2$, 2, and 3-in. diameters, it offers wide application in highly corrosive services (all acids, except HF, to 350 or 450 F depending on concentration, and mild alkalies at moderate temperatures). It is also ideal for those applications where freedom from product contamination or adhesion is required. Corrosion resistance and abrasion resistance are approximately doubled because of the substantially thicker ($^1/_8$ in.) borosilicate glass lining.

The field-cutting feature (patent applied for) offers significant savings through (*a*) less-detailed piping layouts, (*b*) faster installation, (*c*) more convenient plant-piping modifications, and (*d*) inexpensive maintenance.

A new Glasteel pipe can be field cut with standard equipment. The only special requirements are threading dies and a small fire-polishing furnace.

▶ Welding Technique Makes Molybdenum Sandwiches

Sheet and "sandwich" structures of molybdenum can now be made with the aid of a successful welding technique for molybdenum recently developed by the Finn Aeronautical Division of Astrometals Corporation, Hawthorne, N. J., under a contract with the National Aeronautics and Space Administration.

In contrast with "inch-size" samples fabricated from the refractory metal up to now, Finn plans to prepare prototype structures limited in size only by practical limitations of available molybdenum (0.5 Ti) sheet.

The Finn technique yields weldments with good ductility and strength and without cracking.

▶ Aluminum Pipelines Laid Automatically

A fast, amazingly simple method for laying small-diameter aluminum pipe—used as oil-country flow lines and gathering lines—has been developed by the Aluminum Company of America and a major oil company. Automatic pipe-laying equipment digs a 42-in-deep trench, and 2-in. schedule-5 aluminum pipe is unreeled, laid, and back-filled, all in one smooth, uninterrupted operation at approximately 3 mph.

Laying small-diameter pipelines at such high speed is claimed to cut the installed cost to nearly one half that of steel pipe used in the same applications.

The pipe is mounted on a specially built trailer coupled to a plow having a hollow, curved blade. The coiled pipe is unreeled and fed down through the hollow plow blade as a tractor tows it across the field. The uncoiling pipe straightens out on the trench bottom.

According to Alcoa, flow lines and gathering lines can be installed using equipment carrying up to one mile of coiled pipe. The substantial cost reduction accomplished by the unique pipeline-laying method will greatly expand aluminum's participation in these applications. Light-metal lines now are used to take advantage of aluminum's good resistance to soil corrosion, smooth inside surface—which has been found to minimize paraffin buildup—and ease of handling.

▶ Estane VC Resists Weather Deterioration

Estane VC, a new polyurethane material used dramatically in the recent development of a plastic heart and valves, is unique among rubberlike materials for its ability to withstand the deterioration caused by weathering.

Studies revealed the wavelengths of light that are responsible for the chemical changes during weathering and led to the use of carbon black or certain custom-synthesized ultraviolet absorbers as protective agents in the material.

Unlike other natural and synthetic rubbers which require vulcanizing to make them useful, Estane VC has unusually high strength and abrasion resistance without vulcanizing.

▶ Large Tungsten Ingots Produced by Powdered Metallurgy

Large tungsten ingots, weighing up to 200 lb, can now be produced from tungsten powder by indirect sintering in large, high-temperature furnaces, followed by forging at high temperatures.

The process was developed under the direction of Paul Schwarzkopf of New York, N. Y., who is also president and owner of the Metallwerk Plansee in Reutte, Tyrol, Austria. Tungsten ingots were previously limited to about 20 lb.

Nuclear Progress and Outlook

DAMPENING factors for certain segments of the nuclear industry are noted by the Atomic Industrial Forum's year-end survey. These include a slowdown in the Euratom nuclear construction program, cutbacks in certain U. S. government reactor-development programs, overproduction of uranium, and a more conservative appraisal of the current value to industry from utilization of radiation and radioisotopes.

On the positive side, several major reactor-system suppliers are indicating cost guarantees on nuclear-power-plant construction factors over which the manufacturer could maintain control. During 1959 the AEC announced details of technical studies upon which it is basing a 10-yr government plan for nuclear-power development programs to be carried out both at government facilities and at private sites. AEC estimates showed that at least one system, pressurized water, could be developed to the point of being nearly competitive with conventionally fueled plants by 1965.

Other positive high lights of 1959 included: Startup of the privately financed Dresden, Ill., nuclear power station, the world's largest operating power reactor; launching of the *NS Savannah;* addition of five more atom-powered submarines to the nuclear Navy; and sea trials of the Soviet icebreaker, *Lenin*.

There is little encouragement to American hopes for an expanded nuclear equipment market as a result of the Euratom program. Only one of five European reactor-construction proposals is meeting deadline requirements of the Euratom invitation—the SENN plant in Italy, which will be financed in part by the World Bank under arrangements initiated more than two years ago.

Applications of radiation received a setback with deferment of Army plans to operate an ionizing radiation center for radiation sterilization of food. Relatedly, an AEC-sponsored survey revealed that the total net savings realized by major industries from using radioisotopes amounted to just under $40 million annually. This was approximately one tenth of the 1957 AEC estimate and resulted primarily from a redefinition of what constituted actual savings to industry. Returns on isotope and radiation investment are very high in many instances, although only a small percentage of American industrial companies are availing themselves of these opportunities for cost savings and profit increases.

Nuclear Briefs

▶ Homogeneous Reactor Experiment Successful

THE Homogeneous Reactor Experiment at ORNL has been operated at various powers up to 5 mw for 78 per cent of the last six months. The reactor consists of a central zirconium tank containing enriched uranium in the form of uranyl-sulfate dissolved in heavy water, surrounded by a reflector or blanket of heavy water. In the current run the reactor cell has been sealed with the circulating pumps running uninterruptedly for 1600 hr, nearing the longest nonstop run of any power reactor.

▶ Thermionic Converter as Nuclear Topping Device

A survey of thermionic energy conversion in the December, 1959, issue of the quarterly review of *Power Reactor Technology*, prepared for the U. S. Atomic Energy Commission by General Nuclear Engineering Corporation, states that the thermionic converter could conceivably operate as a topping device for nuclear reactors.

One way this might be accomplished is through the use of a reactor fuel element having a double-walled jacket with cesium vapor in a gap between the two walls. The inner wall would be the cathode heated by fission, and the outer wall would be the anode cooled by the conventional coolant. Direct production of electrical energy would accompany the flow of the fission heat through the cesium-vapor space to the coolant. The heat absorbed by the coolant would be converted to electricity by means of the conventional heat cycle with the conventional coolant and turbine-generator system.

About 20 per cent of the reactor heat would be converted directly to electrical energy. If the 80 per cent rejected to the coolant were utilized with 30 per cent efficiency in a conventional system, this would account for 24 per cent of the original fission heat.

Hence the total efficiency of the system would be 20 + 24 = 44 per cent. However, the practical problems involved are numerous.

▶ ZPR-VI, ZPR-IX, and "Juggernaut" Added at Argonne

Three new research-reactor facilities are under construction at Argonne National Laboratory, Lemont, Ill. Two of the units are critical assemblies—Zero Power Reactor 6, ZPR-VI, and Zero Power Reactor 9, ZPR-IX. They are experimental units that produce no power but will provide basic physics information needed in the development of fast-breeder reactors.

The other facility is a low-flux, special-purpose research reactor, "Juggernaut." This light-water research reactor fueled with highly enriched U-235 will operate at a maximum of 250 kw but will be used primarily as a neutron source. It will provide special facilities for calibrating and developing instrumentation for the ZPR-VI and ZPR-IX in addition to serving for general analytic-chemistry and electronics research.

▶ Indian Point Heat Exchanger Arrives

The first of four 60-ton heat exchangers for Consolidated Edison's $100-million, 275,000-kw Indian Point nuclear power station has been received at the site.

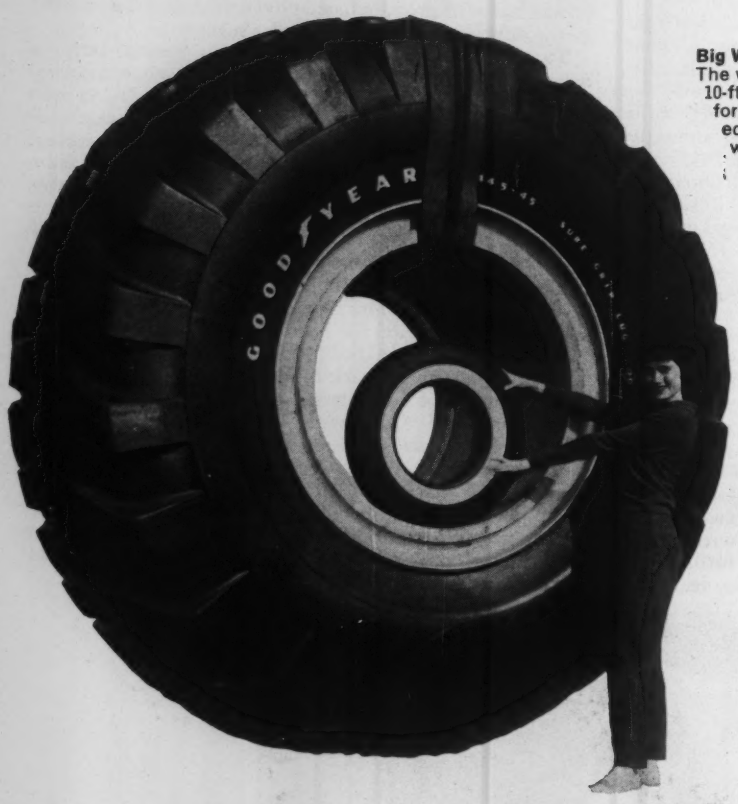
A mammoth U-shaped 4-ft-diam tube, the heat exchanger, made at Babcock & Wilcox Company, has more than 10 miles of 1-in. stainless-steel tubes inside. It is 40 ft long and 13 ft wide. The unit will use heat generated by nuclear fission to make steam.

Together with the nuclear system, the steam generators will be installed in the already completed 160-ft-diam containment sphere made of 1-in-thick steel plate. Other major components the company is supplying are the reactor core and vessel, a pressurizer tank, and associated equipment.

This 60-ton heat exchanger will be part of one of the four steam generators at Indian Point

Atom Watchers
Trapped on a jiggling plate, hundreds of glass beads act out the role of atoms at the General Electric Research Laboratory, Schenectady, N. Y. The flat plate, suspended by springs, is moved by a motor mounted beneath. The model is designed to reveal how large numbers of atoms may move and interact in solid, liquid, and gaseous states. At **left**, behavior in a liquid—loosely packed, no pattern visible. At **right**, a solid has formed, with grain boundaries between adjacent groups.

PHOTO BRIEFS

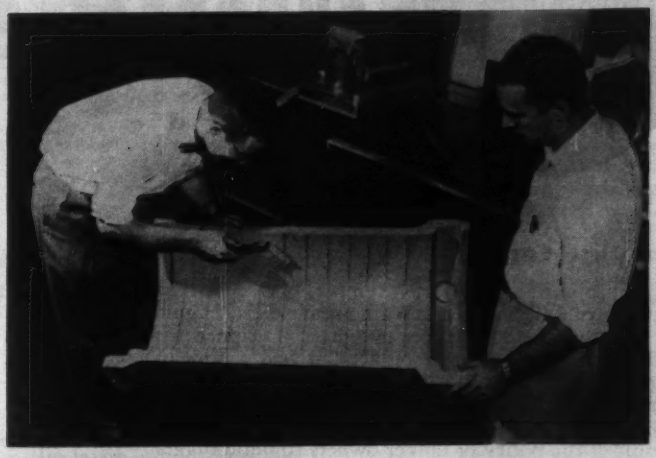


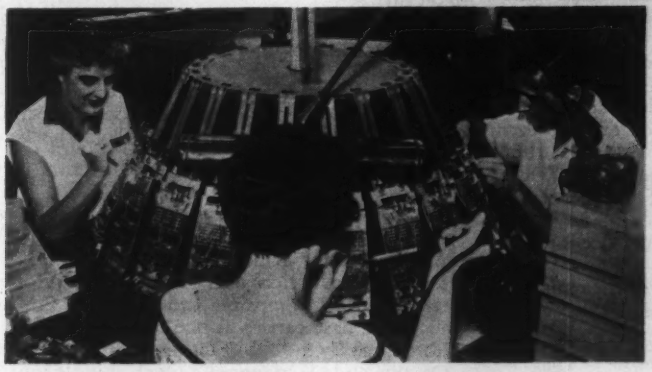
Big Wheel
The world's largest tire, this 10-ft giant was developed by Goodyear for use on heavy, earth-moving equipment. It is 4 ft wide and weighs two tons. Its rim, also the largest, adds another ton. The price for a set of four (rims extra) is $56,000. Ask for size 44.5 × 45.

Remote-Control Manipulator
This powered manipulator, by General Mills, which permits high-precision operation within a radioactive....

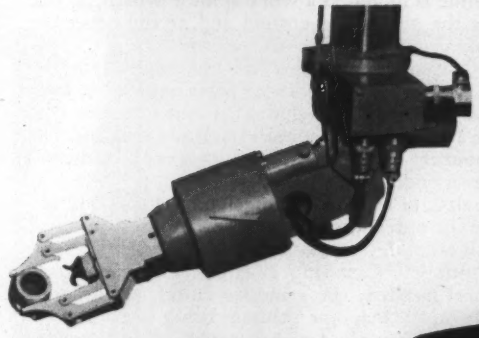
Glass Heat Exchanger
Corning Glass has introduced this 60-sq-ft unit for service with corrosive fluids. It is glass jacketed for regenerative service, steel jacketed for cooling.

Plastic Jet-Engine Housing
Westinghouse at Kansas City applied this reinforced-plastic housing to the compressor section of a standard jet engine. It has sustained 150 hr of full-scale operation. The plastic resembles that used in nose cones.





Rotary Assembly Line
At Martin's Baltimore Division, this wheel has replaced the assembly-line workbench for electrical and electronic components of missiles. Advantages: Less space, more comfort, and absence of customary brackets and jigs.



....area, is offered in the price range of master-slave devices. It will fill a need in small industrial and college laboratories.

Levacar "Mach I"
This is Ford's first full-scale wheelless vehicle. Wettlaufer Engineering Corporation of Detroit built the car—in just three weeks and four days—using epoxy-resin plastic formulations for the inside surfaces. Ren Plastics, of Lansing, Mich., supplied the epoxy resin.

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

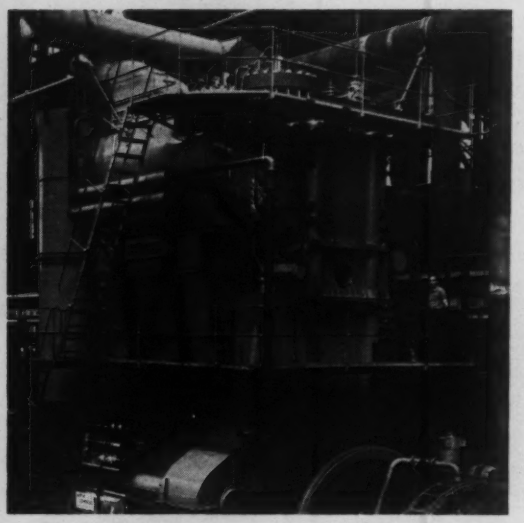
Marine Diesel Engine

THE "European Survey" for November, 1959, described and illustrated a Burmeister & Wain marine diesel engine which developed 2100 bhp per cylinder. Designed for propelling large single-screw tankers, it had a bore of 840 mm and a stroke of 1800 mm. It was remarked at the time that all the makers of large marine diesel engines are busily developing high-power engines of this class as a result of the policy of tanker owners to build bigger and bigger ships, while showing a marked preference for single-screw propulsion.

FIAT Stabilimento Grandi Motori, of Turin, Italy, who have specialized in this type of work for years, have produced an engine of even higher hp per cylinder. Having received an order to engine a 38,000-ton tanker, now under construction at the Castellammare shipyard, they prepared a design for one with nine cylinders of 900-mm bore and 1600-mm stroke; but, in view of its exceptional size, they built first a two-cylinder "pilot plant" with the same cylinder dimensions, which has been tested exhaustively in their works.

They now report that this engine has given the remarkable output of 2650 bhp per cylinder, which they claim to be the highest ever reached in an internal-combustion engine.

Two-cylinder marine diesel engine has output of 2650 bhp per cylinder. Engine is part of a "pilot plant" for a 38,000-ton tanker to have nine cylinders.



The speed was 127 rpm and the piston speed, therefore, 6.8 m/sec (1335 fpm). The mean effective pressure was 9.2 kg per sq cm (131 psi). At this high power the fuel consumption is 165 gm/bhp/hr, but at the more normal output of 2000 hp per cylinder, which would probably be about the maximum at sea, it comes down to 155 gm on medium-grade fuel and about 152-153 gm on first-grade diesel oil.

In design the engine generally follows established FIAT practice, with welded bedplate and crankcase, through bolts connecting the cylinders to the bedplate, cross scavenging, and pressure-fed exhaust turbochargers. The nine-cylinder engine will have four turbochargers. It will be just under 60 ft long and, from the level of the seatings, 36 ft high.

Internal-Helical-Gear Grinder

A MACHINE for grinding the internal helical teeth of gas-turbine reduction gears has been developed by the Gear Grinding Company, Ltd., Shirley, Solihull, England. The base carries at one end a work slide which is reciprocated by a double-acting hydraulic cylinder.

On this slide is mounted a work spindle which, at one end, carries the gear to be ground and at the other the indexing and lead-generating mechanism.

This work spindle comprises two concentric spindles. To the inner one is secured an index plate having the same teeth as the gear to be ground; the outer carries two sectors, one attached to the spindle itself and the other free to pivot about it. They are normally locked together by a hydraulic cylinder.

The base disk of the lead-generating mechanism is also attached to the outer spindle and is secured by steel tapes to a horizontal slide, so that movement of the slide rotates the spindle. Grinding is effected by the Orcutt formed-wheel method, the grinding wheel, carried on a double slide on the machine column, being formed to the shape of a tooth space by two separate diamond dressing mechanisms, operated hydraulically.

In grinding, the work slide reciprocates so that the wheel passes through a tooth space on the gear and then stops while the gear is indexed to the next tooth space. A flow control valve in the pressure oil circuit sets the work slide speed to any desired figure between 0 and 30 fpm.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Terylene Ducting for Mine Ventilation
"Terylene" ventilation ducting at Parsonage Colliery, Leigh, Lancashire, England. The National Coal Board has placed an order for 30 miles of the ducting composed of twistless Terylene base coated with polyvinyl chloride. The fire-resistant fabric ducting weighs only 2½ oz per sq yd.

New Reactor for O.E.E.C. Research

THE ZENITH reactor at the Atomic Energy Establishment at Winfrith Heath, Dorset, England, started operation on December 19, 1959. It is the first reactor at this new plant of the United Kingdom Atomic Energy Authority and is to be used initially by the international staff of the Organization for European Economic Co-operation, High Temperature Reactor Project, to provide design data for a 20-mw high-temperature gas-cooled reactor experiment, known as DRAGON, also to be built at Winfrith.

This DRAGON Project is a joint undertaking by twelve countries—briefly, the six Euratom countries, and Austria, Denmark, Norway, Sweden, Switzerland, and the U.K.—who have a five-year agreement to undertake this research, the cost of which is likely to be between $35 and $40 million; it is expected to lead to the development of improved materials for use at high temperatures.

The core of the ZENITH reactor comprises 235 fuel elements, 8 ft high and 4 ft diam, in the form of graphite cylinders containing pellets of fissile uranium oxide, fertile thorium oxide, and graphite. The ends of the elements are of solid graphite and, with the 3-ft-thick graphite annulus around the fuel, form a reflector which returns some of the escaping neutrons into the core, thus saving fuel. The core is enclosed in a pressure vessel through which hot nitrogen gas is pumped in a closed circuit, raising the core mean temperature to 800 C. The pressure vessel and associated plant are contained in an airtight building.

The amount of heat produced by the nuclear reaction is very small, as the maximum nuclear power is 100 watts; this is ample to provide the desired physical data, while being low enough to avoid inducing such activity in the fuel that rearrangement of the core would be difficult to carry out.

The effluent will be only very slightly radioactive, but (largely to allay public anxiety) it will be discharged two miles out to sea. The reactor site is five miles inland, and leakproof operation over this distance is insured by laying the pipe within another pipe. The radioactive effluent flows through the inner pipe and the nonradioactive wastes flow through the annular space between the two pipes. Any radioactive leakage therefore escapes into the annular space, where it would be considerably diluted. It would also be detected at once by an automatic monitoring system.

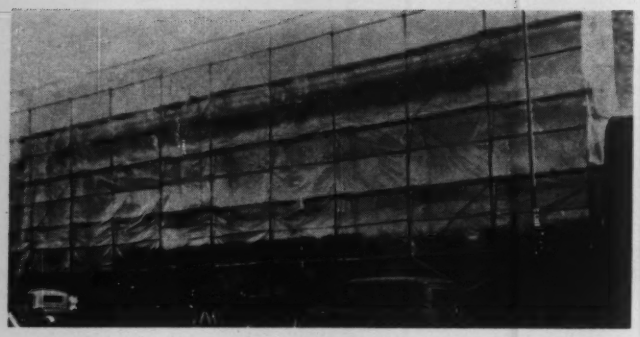
The pipes are of mild steel and are welded end to end, all the welds being radiographically examined. The thickness of the pipe walls is ½ in. The metal is given an anticorrosive coating, and in addition the lines laid on the sea bottom are cased in concrete and lie in trenches blasted through the inshore reefs. The seaward ends of the pipes discharge (through diffusers, to give maximum dispersion) into currents which will carry the effluent away from the shore into deep water.

ZENITH Reactor at Winfrith Heath, Dorset, England. View showing top face of graphite reflector. The holes in the inner ring of bricks are for control rods and flux-measuring apparatus. Core support grid can be seen in central space and some of top gas-inlet pipe above reflector may also be seen.

Substance in Brief of Papers Presented at ASME Meetings

M. ZANFARDINO
Staff Editor

ASME TECHNICAL DIGEST



Plastic films are finding large and varied use in the construction and the agricultural industries. The limits of its applications are guided only by the imagination of the user. Polyethylene film protects passerby and adjacent equipment while a store is being resurfaced. (59—A-261)

2-mil black polyethylene is used on a bank to prevent soil erosion until vegetation is well rooted (59—A-261).

Typical applications of Videne, new polyester and surfacing film, which offers to industry a new surface with unlimited possibilities of design flexibility and original effects (59—A-316)

Rubber and Plastics

Plastic Films in Construction and Agriculture..59—A-261... By T. E. Werkema, The Dow Chemical Company, Midland, Mich. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Plastic films represent a relatively new but rapidly growing segment of the vigorous plastic industry. These films are finding large and varied use in the construction and agriculture industries primarily because of their weather resistance, heat resistance, translucence, low cost, and ease of handling.

In 1958 there were approximately 25 million pounds of plastic films used in these two industries. Considering the newness of these films, this growth is extraordinary.

From a survey of construction uses of polyethylene in 1957, it was reported, for example, that there were still many local building-supply dealers who did not handle the film. Various estimates have indicated that use in these two industries should grow to about 65 million pounds by 1963, an increase of 325 per cent. The future markets will depend not only on the physical and economic characteristics of the materials, but also on the imagination with which these materials are used.

This paper describes certain applications of polyethylene, in particular, and discusses physical properties of polyethylene, polyvinyl chloride, polypropylene, polyester, and cellulose acetate.

Videne—A Polyester Laminating and Surfacing Film..59—A-316... By C. W. Taylor, Goodyear Tire and Rubber Company, Akron, Ohio. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Videne is a thermoplastic polyester laminating film which is water clear, unoriented, amorphous, and noncrystallizing. By chemical definition, Videne is a linear copolyester. Videne is produced by extrusion methods in widths up to 56 in. and in thicknesses ranging from 200 to 750 gage.

Its outstanding properties are abrasion resistance, high strength, high hardness, good optical properties, good resistance to gaseous permeability, excellent electrical properties, and service temperature ranging from minus 40 to 200 F.

Videne is compatible with rigid vinyl papers, textiles, foils, metal surfaces, and wood surfaces, and is usually processed by rotary or press-platen laminations. The material has excellent vacuum-forming characteristics which will extend to the limitations of the substrate material.

Videne film finds major applications in the following areas:

1 Plywood and associated products such as particle board, composition board, fiber board, and the like.
2 Paper and textiles.
3 Metal.
4 Plastics.

Videne can be utilized as a clear or satin-finished film; will be produced in pigmented opaque films; can be reverse or directly printed; and can be subjected in all cases to embossing designs.

This offers to industry a new surface with unlimited possibilities of design flexibility and original effects. The stylists, designers, and architects have a new film that can stretch their imagination to limits not possible in the past.

Polyethylene Pipe Progress..59—A-321... By A. Stockfleth, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Polyethylene pipe has proved successful because it was strong, flexible, tough at low temperatures, imparted no taste or odor, was chemically inert and resistant to many of the corrosive elements that frequently are troublesome to iron and steel, copper or brass, and because of this there appears to be a natural market for polyethylene pipe.

This paper concerns itself with the development, current status, and future position of polyethylene pipe.

Emphasis is placed on product development, pipe manufacture, and pipe testing, and the relationship these have to product utility.

The various types of polyethylene used in pipe are discussed as are the various zones of progress—materials, processing, fittings, standardization, and the user.

Factors Affecting the Long-Term Performance of Polyethylene Plastic Pipe.. 59—A-323... By W. P. Acton, Hercules Powder Company, Wilmington, Del. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

There are few applications for plastics which are more demanding than pipe. In a plumbing system, the plastic pipe must operate under a constant internal stress for many years. It has long been recognized that variations in materials or in process techniques can affect the performance of plastic pipe, but only recently have the effects of these variations been determined quantitatively.

Although fabrication techniques can affect the performance of plastic pipe, the scope of this paper is limited to the effect of the choice of polyethylene. The effect of time and variations in type of polyethylene on the stress-rupture behavior of polyethylene pipe is discussed. The effect of density and molecular weight of polyethylene on ductile and brittle-failure mechanisms is considered. The long-term performance of polyethylene pipe must be predicted by extrapolation of accelerated test results obtained at elevated temperatures. Extrapolation methods are discussed.

There are a wide variety of polyethylene materials available today. All of them have different properties and not all of them are suitable for pipe applications.

The ideal polyethylene for pipe would have the highest density (consistent with coiling) which would give it the highest strength level; and the highest molecular weight (consistent with fabrication) to insure good long-term aging properties.

Because of the great difference between polyethylene resins, every material must be tested at three temperature levels, at least, for not less than 10,000 hr. Only then will sufficient data be available for intelligent extrapolation. The methods of extrapolation available, both graphical and the Larson-Miller concept, seem well founded.

Once the stress-rupture behavior of a certain pipe has been established, it is possible to assign a permissible operating stress somewhat below the stress expected to cause failure after a long period of time. This provides a large margin of safety to insure the satisfactory long-term performance of polyethylene pipe.

Uniform Two-Way Orientation of Plastic Films..59—A-113... By M. O. Longstreth, Mem. ASME, and Turner Alfrey, Jr., Dow Chemical Company, Midland, Mich. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

In order for a plastic film to be stretched at equal rates in the longitudinal and the transverse direction, a highly specific geometrical flow pattern must be established in the stretching zone.

This flow pattern involves diverging radial flow lines; the velocity at any point is directly proportional to the distance from the convergences point of the flow lines.

These geometrical facts lead to certain design requirements for a machine to be used in the production of plastic film with uniform two-way orientation.

In order for new concepts to be expressed in terms of practical working designs for machinery, mechanical development is required.

Power

A Test to Anticipate the Performance of Steam Piping at 5000 Psi and 1200 F.. 59—A-230... By G. C. Wiedersum, Jr., Assoc. Mem. ASME, Philadelphia Electric Company, Philadelphia, Pa. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The Eddystone No. 1 Unit will operate under steam conditions of 5000 psi and 1200 F. Tests are being made concurrent with the operation of this unit to anticipate the performance of the Type 316 main steam piping.

The main steam piping of Eddystone No. 1 includes 93 shop welds and 75 field welds, plus 41 penetrations and attachments involving welds. Each one of these must be considered as a possible source of difficulty in the light of what little information and experience exists. There is not much known about the formation and effect of sigma phase other that that it is likely to form slowly at 1200 F. There is also the possibility, however remote, of some other unexpected phase change in Type 316 that would not become apparent until after a long period of exposure at 1200 F, similar to the unexpected graphitization that occurred in the welds of carbon-moly piping after several years of exposure.

In view of these uncertainties, it was decided to develop a test that would predict as closely as possible the "in-service" performance of the Eddystone No. 1 main steam piping. Even if the test results were not obtained before the unit went into service, it would still permit taking some remedial action in the plant to forestall any difficulty that might be revealed in the test.

Determination of the test conditions is described, design and operation of the test, and some preliminary results are noted in this paper.

The Distinguishing Aspects of Marine Engineering..59—A-202... By G. L. West, Jr., Assoc. Mem. ASME, The University of Michigan, Ann Arbor, Mich. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Unique characteristics of marine engi-

neering are described and emphasized through comparison between the fields of marine and mechanical engineering. Marine engineering includes a wide range of engineering problems and, therefore, necessarily demands great versatility.

As a preface to outlining the distinguishing aspects of marine engineering, a brief review of shipbuilding and the shipping industry is given.

The marine engineer's job, as distinct from the naval architect's job, is outlined and the requisite formal education for marine engineering is treated. Also included in an Appendix are the mechanical and marine engineering curriculums.

Research Problems Relating to Production and Quality Control of Ultrapure Feedwater for Eddystone Station..59—A-240... By J. A. Levendusky and V. J. Calise, Mem. ASME, Graver Water Conditioning Company, New York, N. Y. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Results are presented of an investigation undertaken as part of the Eddystone Research Program to provide the information that is required to insure the production and quality control of the ultrapure condensate feedwater required for the Eddystone station.

The design of the supercritical boiler has forced the creation of a new criterion for determining water purity for this type of plant.

Pilot-plant data are presented on the filtration and demineralization process for treating condensates. Specific design features were incorporated into the design of the large-scale plant equipment on the basis of the pilot-plant data.

Analytical measurements and the development of a new automatic instrument for measuring suspended solids are also discussed.

The true test of operation of the condensate-purification system will be made when the Eddystone Station goes into operation. Based on the pilot-plant data, the ability of the equipment selected to produce the ultrapure water required for the Eddystone Station has been confirmed.

Basic information has been obtained on the operating characteristics of the precoat filters and ion-exchange equipment which will permit the operation of this equipment in the most efficient manner.

Also, results of test work have:

1 Provided for filtration as an important part of the purification cycle for the removal of suspended solids.

2 Established that iron and copper compounds will be reduced to the desirable levels and this is accomplished by filtration, not ion exchange.

3 Demonstrated that in the event of a condenser failure the mixed-bed units will remove the solids and silica effectively.

4 Extremely accurate analytical methods were worked out for plant control, and a new analytical instrument, The Tape Analyzer, will be used to aid in monitoring the system so as to insure that ultrapure water is obtained at all times.

Advances in Steam Turbines for Marine Propulsion..59—A-263... By A. D. Somes, Mem. ASME, General Electric Company, West Lynn, Mass. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1960).

Advances in the design and construction of steam turbines for the propulsion of ships growing out of current trends in the construction and operation of merchant ships, as distinct from naval vessels, are considered.

The effects of increases in power and steam conditions, and changes in classification rules, are examined and assessed in relation to the turbines.

New concepts and methods in design are discussed and experience with advanced designs is indicated.

Some examples of actual details of construction developed to meet new conditions are presented.

Thermal Instability in High-Speed Gearing..59—A-118... By W. P. Welch, Assoc. Mem. ASME, and J. F. Boron, Westinghouse Electric Corporation, Philadelphia, Pa. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to Oct. 1, 1960).

Thermal-expansion effects in gearing have usually been considered from a steady-state point of view.

A theory of thermal instability is developed which takes into account the tendency of the thermal effects to be regenerative.

This theory provides an adequate and complete explanation for several previously unexplained cases of tooth failure in high-speed, high-horsepower reduction gears.

Experimental verification of the theory is presented and some of the conditions for avoiding thermal instability are described.

The Critical and Two-Phase Flow of Steam..59—A-223... By W. G. Steltz, Assoc. Mem. ASME, Westinghouse Electric Corporation, Lester, Pa. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Results of a digital-computer and analytic study of the critical flow of a compressible fluid are presented in this paper. The expanding flow of a fluid in a single-phase region as well as the expansion of a fluid to a two-phase region is considered and described by analytic expressions relating choking velocity, critical pressure ratio, and flow per unit area characteristics.

A comparison is made of the analytic results which assume a constant value of the isentropic expansion exponent, with the digital-computer results using the actual properties of steam.

All analyses assume the fluid to be in thermodynamic equilibrium.

A skeleton Mollier diagram is presented for steam showing the exponent in the wet and superheated regions.

The choking velocity is presented in plot form as a function of the inlet conditions as well as state point conditions; critical pressure ratio is presented as a function of inlet conditions.

The critical flow per unit area is presented in the form of a factor K plotted versus inlet conditions; this factor K when multiplied by inlet pressure produces the desired value of critical flow.

Fuels

Relationship of Coal-Ash Viscosity to Chemical Composition..59—Fu-4... By W. L. Sage and J. B. McIlroy, The Babcock & Wilcox Company, Alliance, Ohio. 1959 ASME-AIME Solid Fuels Conference paper (multilithographed; to be published in **Trans. ASME—J. Engng. for Power;** available to Aug. 1, 1960).

With the growth of the slag tap boiler, the ability to predict accurately the fluid characteristics of the ash by laboratory means becomes increasingly important.

In the past, because of the smaller units and the more abundant sources of coal, a miscalculation of coal suitability could usually be corrected by changing fuel sources. However, many modern plants because of location or long term contracts are often committed in advance to burn a specified coal.

Furthermore, the flow characteristics of an ash in relation to furnace temperature have considerable bearing on the design and selection of firing equipment.

This paper discusses information on coal-ash behavior in the temperature range suitable for liquid ash removal and shows how this is related to boiler design and fuel characteristics.

A description of a method for predicting slag viscosity from ash analysis and fusion temperatures is given.

Also, a method is shown for predicting the flux requirements to obtain desired slag flow characteristics from an unsatisfactory fuel.

Machine Design

Some Applications of the Cycloid in Machine Design..59—A-134... By E. P. Pollitt, Armour Research Foundation, Chicago, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

Cycloidal motions have many applications in mechanical engineering.

The multilobed epicycloid has sharply pointed cusps; therefore a machine element performing an epicyclic motion can be utilized for performing operations requiring a corresponding action, like folding of flexible materials or feeding of components from a stack.

A speed reducer, distinguished by extreme compactness, is based on the use of an epitrochoidal cam.

Linkages, which perform approximately straight-line motions, can be designed so that they approximate the motion of the center of the generating circle of an orthocycloid.

A Discussion of the Vibration Characteristics of a Simple Mechanical Connection..59—A-41... By Arthur Sorenson, Jr., Assoc. Mem. ASME, General Motors Corporation, Milwaukee, Wis. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

The behavior of a simple mechanical connection over an extended frequency range is analyzed with particular reference to vibration transmission and isolation.

The limitations inherent in a simplified analysis are clarified by a more refined treatment of the problem.

The significance of higher critical frequencies associated with the distributed mass of the connection is pointed out, and this leads to a more generalized concept of rigidity.

A qualified definition of rigidity is subsequently introduced, and the corresponding performance characteristics of a vibration transmitter and isolator are discussed.

The dependency of performance criteria on the type of excitation is emphasized, and the essential ideas embodied in the paper are illustrated in an example.

Positive-Acceleration Clutch..59—A-54... By R. C. Ebersold, The Warner and Swasey Company, Cleveland, Ohio. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Positive-acceleration clutches were developed for the auxiliary cross slides on a single-spindle automatic turning machine. The clutches allow one or both of the cross slides to be started, rapid-traversed, fed and stopped precisely in the desired relationship to the mainslide, with smooth and shockless engagement.

The clutches can be used for smooth starting and stopping of drive shafts. Where rotary motion is intermittently required, a fixed timing relationship can be established to other drives.

In either position (engaged or disengaged) positive control of the driven member is maintained. By associating a dog clutch with the positive-acceleration clutch, large torque transmittal is accomplished with small components.

An application of the principles in the operation of machine-tool slides is shown and explained in this paper.

Study of Critical Velocity of Stick-Slip Sliding..59—A-146... By B. R. Singh, Britannia Engineering Company, Ltd., Titaghur, West Bengal, India. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

The motion of a body sliding under boundary friction, at a velocity slower than a particular critical velocity of the system, proceeds in a discontinuous or stick-slip form.

This paper presents a theoretical analysis and an experimental study of the critical velocity of stick-slip sliding

The influence of various parameters, such as friction, damping, stiffness, and sliding mass of the system on the critical velocity, was studied on a mechanical model arranged on a milling machine.

The arrangement was also simulated on an electric analog computer.

Good correlation was observed between the theoretical values and the experimental results on the mechanical model and on the analog computer.

Design by Quantitative Factor of Safety..59—A-48... By Hsuan-Loh Su, Imperial College, London University, London, England. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

The traditional safety factor has a qualitative meaning only.

However, it can be quantitatively interpreted through the possible variations of the components in a design as well as the probability of safety.

The proposed design method based on such a safety factor gives not only a more rational but also a more economic design than the conventional methods.

The Measurement of Very Low Frictional Torques in Rotating Equipment..59—A-43... By M. Zaid, Assoc. Mem. ASME, Technik Incorporated, Syosset, N. Y.; and I. S. Tolins, Assoc. Mem. ASME, Ford Instrument Corporation, Long Island City, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

In the design of high precision, rotating equipment such as air bearings, gyroscopes, and the like, it has become possible to reduce the frictional torques to "almost zero" values. The measurement and classification of the sources of these minute torques during rotation is exceedingly difficult, but very important for correct application and further design improvement.

It is the purpose of this paper to present two techniques for the measurement and discrimination of the torques, and an example showing the accuracy of these techniques.

Although these methods were designed specifically for the measurements of low torques, they work equally well for any magnitude and as such present a good evaluation technique. A comparison made with the values obtained by one of the better "direct" methods indicates that the direct method is inadequate.

Refinement of Finite Difference Calculations in Kinematic Analysis..59—A-53... By B. W. Shaffer, Mem. ASME, New York University, and Irvin Krause, Assoc. Mem. ASME, City College of New York, New York, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

First and second finite-difference expressions are derived for the first three derivatives of displacement with respect to time.

The numerical results obtained by applying these difference expressions to a specific cam-follower mechanism are found to be in good agreement with the values obtained by successive differentiation of the displacement-time equation.

Procedures for evaluating and improving the numerical results are also discussed.

Deformation and Moments in Elastically Restrained Circular Plates Under Arbitrary Load or Linear Thermal Gradient..59—A-39... By M. Zaid, Assoc. Mem. ASME, and M. Forray, Republic Aviation Corporation, Farmingdale, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

The problem of a circular plate, with a central hole, elastically constrained against rotation and deflection, acted upon by a transverse linear temperature gradient or a general axisymmetrical loading condition is considered in this paper.

With the aid of presented graphs and simple algebraic equations, it is a relatively simple matter to construct the desired deflection and stress pattern for any combination of elastic constraints and load distribution.

Mechanical Vibration Filters With Nonlinear Characteristics..59—A-42... By W. J. Worley, Mem. ASME, University of Illinois, Urbana, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.**; available to Oct. 1, 1960).

The steady-state and transient solutions for the motion of a mass coupled through a linear spring and viscous damper to a vibrating base are well known. To determine whether a nonlinear spring and a nonlinear damper will improve the isolation characteristics of a suspension for steady state as well as for transient vibrations is the subject of this paper.

The behavior of a single degree of freedom system consisting of a single mass mounted on a spring and damper attached to an oscillating base is investigated. Steady-state and transient sinusoidal oscillations are applied to the base to which the suspension is attached. The response of the mass is recorded for various combinations of linear and nonlinear springs and dampers. Solutions are obtained with a differential analyzer.

Hydraulics

On Cathodic Protection in Cavitation Damage..59—A-170... By M. S. Plesset, Mem. ASME, California Institute of Technology, Pasadena, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

An experimental procedure has been developed which makes possible accurate and reproducible determinations of cavitation damage.

This procedure has been applied to a study of the effect of cathodic currents on cavitation damage.

A series of experiments, in which the test liquid was a solution of salt in water, showed a reduction in cavitation weight loss for all of the materials examined when the test specimen was made the cathode of an electrolytic cell and when the conditions were such that gas was evolved at the specimen surface.

This protective effect against cavitation damage increased with increasing magnitude of the cathodic current.

These observations support the view that the protective effect was due to the layer of hydrogen gas evolved on the surface of the specimen.

A similar protective effect was observed when the specimen was made the anode in a test liquid which was buffered distilled water; in this situation the gas evolved at the specimen surface is oxygen.

Additional evidence for this protective mechanism on a gas layer on the specimen surface was found in a series of experiments in which the voltage applied to the cell was reduced to a level at which no gas was evolved on the surface.

There was then no protective effect with the specimen, cathodic or anodic.

Correlation of Cavitation Inception Data for Centrifugal Pump Operating in Water and in Sodium-Potassium Alloy (NaK)..59—A-156... By A. G. Grindell, Assoc. Mem. ASME, Oak Ridge National Laboratory, Oak Ridge, Tenn. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

The static head at pump suction at the time of cavitation inception was correlated for water and for 1500 F NaK on the basis of the differences of the vapor pressures of the two liquids.

The difference between the vapor pressures, for the same conditions of pump speed and liquid flow, was added to the water-test cavitation inception value; this proved to be a good approximation to the experimental value found for cavitation inception with NaK.

Some Corrosion Effects in Accelerated Cavitation Damage..59—A-52... By W. C. Leith, Mem. ASME, Dominion Engineering Works, Montreal, P. Q., Canada; and A. L. Thompson, McGill University, Montreal, P. Q., Canada. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

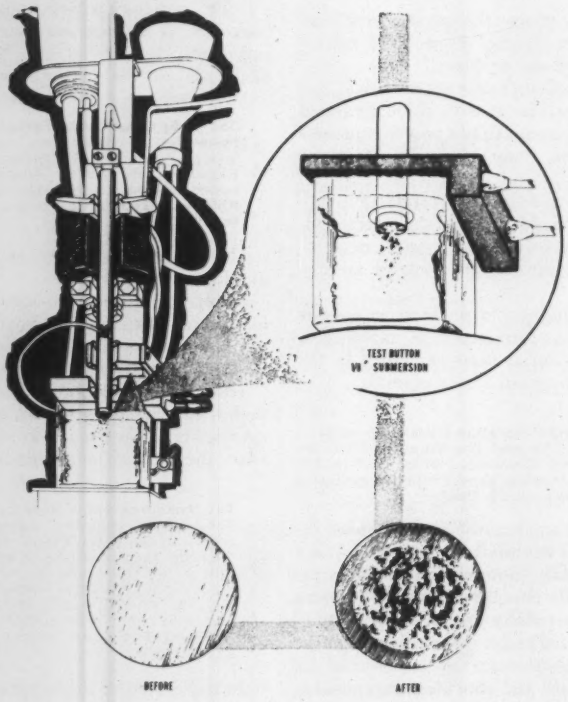
Cavitation can be described as a hydrodynamic phenomenon which relates to the formation and collapse of vapor bubbles in a flowing liquid. These bubbles form in regions where the local pressure is reduced below the vapor pressure at that temperature; and conversely, these bubbles start to collapse as soon as the local pressure increases above the vapor pressure.

The conjoint mechanical-chemical destruction of metals by accelerated cavitation in a magnetostriction apparatus indicates relative effects of the metal properties (hardness, metallurgical structure, corrosion-fatigue limit) and of the liquid characteristics (temperature, pressure, wettability) which have been confirmed by field experience in hydraulic turbines and in water-cooled diesel cylinder liners.

The Selection of Length and Head Scales for Cavitation Tests..59—A-40... By Pierre Danel, Assoc. Mem. ASME, and Jacques Duport, SOGREAH, Grenoble, France. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

The most important problems to be solved in investigating cavitation on scale models concern choice of length and velocity scales and determining if there

Schematic diagram of magnetostriction apparatus for producing accelerated cavitation (59—A-52)



are lower limits beyond which these characteristics can be scaled down. In dealing with turbomachines, or more generally flow under pressure, it is also necessary to know whether the head (or velocity) scale and length scale can be chosen independently of each other as is done where cavitation does not occur.

In this paper some of the precautions are described that have to be taken to obtain a correct representation of the pressure field in a cavitation model and to be certain of the critical pressure that has to be used.

Rotating Wakes in Vaneless Diffusers.. 59—A-104... By R. C. Dean, Jr., Assoc. Mem. ASME, Ingersoll-Rand Company, Phillipsburg, N. J.; and Yasutoshi Senoo, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

Experimental investigations have shown that the flow discharged from a centrifugal compressor or pump impeller into a diffuser is often unsteady and axially asymmetric.

A theory based upon a simplified model is developed for this type of flow.

The theory predicts a significant reversible work transfer between parts of the flow with different velocities.

This effect only occurs in cases of rotating distortion patterns; stationary distortion patterns, therefore, behave differently.

Theoretical results are compared to measurements and good agreement is found.

The implications of the theory have been investigated by means of machine computations and are discussed herein.

Radial Distributions of Temporal-Mean Peripheral Velocity and Pressure for Fully Developed Turbulent Flow in Curved Channels..59—A-51... By A. W. Marris, Assoc. Mem. ASME, University of British Columbia, Vancouver, B. C., Canada. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

Experimental results are presented for the radial distributions of pressure and peripheral velocity for the turbulent flow of water in two closed curved channels of rectangular cross section and large depth-to-width ratio. The traverses were taken at the equatorial section of the channel and sufficiently far round the curve for the effect of curvature on the mean motion to be fully established. The two channels employed had widely differing mean radius-to-width ratios n. The data obtained for a wide range of flow rates in the channel with a larger n indicated that Reynolds similarity existed between the flows in this channel. These data are compared with the pressure and velocity profiles predicted by potential flow theory and with a semiempirical logarithmic velocity distribution.

Results obtained for the channel with smaller n showed that at above a certain Reynolds number an anomaly occurred in the flow, manifesting itself as an unstable "belt" of faster moving fluid, which moved outward from the inner wall as the Reynolds number was increased. This effect, considered to be the consequence of upstream stall, was accompanied by an adverse longitudinal-pressure gradient at the inner wall of the channel. It appeared to be eliminated by the insertion of an upstream splitter vane.

Roughness Effects on Frictional Resistance of Enclosed Rotating Disks..59—A-55... By R. E. Nece, Assoc. Mem. ASME, University of Washington, Seattle, Wash.; and J. W. Daily, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

The effects of surface roughness on the frictional resistance of enclosed rotating disks have been studied experimentally.

Torque data were obtained over the range of disk Reynolds numbers 4×10^3 to 6×10^6 for three different relative roughnesses a/k of 1000, 2000, and 3200 at three axial-clearance-to-disk-radius ratios s/a of 0.0227, 0.0609, and 0.112 for a constant, small, radial tip clearance.

The existence of four possible basic flow regimes in the axial gap between the disk and casing wall was verified.

Empirical expressions have been presented which predict the initial point of onset of turbulence in the flow within the boundary layer on the disk, the point at which the surface roughness becomes fully effective, and the magnitudes of the resistance coefficients in the zone of fully rough turbulent flow.

The similarities and differences between smooth and rough-disk torque behavior, and to a limited extent boundary-layer behavior, have been noted.

A Torsional Vibration Problem as Associated With Synchronous Motor Driven Machines..59—A-141... By R. N. Brown, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

Certain component failures in synchronous-driven high-inertia rotating equipment may be traced to a phenomenon peculiar to the starting characteristic of a salient-pole-synchronous motor: A synchronous motor contributes a pulsating torque during the starting cycle.

Though this fact is well known in itself, it has not been associated with the effect it may have on a high inertia load.

The pulsating torque may excite a torsional resonance, which will in turn induce very high stresses in the driven train members.

Heat Transfer

Laminar Skin Friction and Heat Transfer on Flat Plates With Wedge-Shaped Grooves in Flow Direction..59—A-143... By T. F. Irvine, Jr., North Carolina State College, Raleigh, N. C.; and E. R. G. Eckert, Mem. ASME, University of Minnesota, Minneapolis, Minn. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer**; available to Oct. 1, 1960).

The flow of fluids in ducts having noncircular cross sections has been studied by the authors and reported in a number of publications.

In one of the cross sections investigated, that of an isosceles triangle with a height-to-base ratio of 10, it was observed that the flow in the narrow apex region behaved in a very peculiar manner in the neighborhood of the transition point.

It was shown by flow-visualization techniques and velocity-field measurements that the influence of the converging walls in corner regions was such as to exert a stabilizing influence on the flow field. Thus, although the flow in the core of the fluid near the triangle base was turbulent, a significant portion of the fluid near the apex was laminar and remained so at high Reynolds numbers.

This stabilizing phenomenon gave rise to the speculation that in external flow it might be possible to delay transition by installing wedge-shaped grooves in the flow direction. Thus an interest was generated in studying the boundary-layer development in such grooves.

The present paper reports the results of such an investigation using the von Karman-Pohlhausen-Kroujiline integral equations to study the velocity and thermal boundary-layer growth and the associated skin friction and heat transfer.

Sublimation Mass Transfer Through Compressible Boundary Layers on a Flat Plate..59—A-137... By T. K. Sherwood, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass.; and Olev Trass, University of Toronto, Toronto, Ont., Canada. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer**; available to Oct. 1, 1960).

Data are reported on rates of sublimation mass transfer from an adiabatic, sharp-edged flat plate exposed to air

streams at Mach numbers of 0.43, 2.0, and 3.5. Thickness decrease of the subliming naphthalene coating, plate surface temperature, and flow conditions were measured.

An analysis of friction and heat transfer in turbulent compressible flow has been extended to mass transfer at low rates.

Agreement between theory and data is good over the entire range of Reynolds numbers from 3×10^4 to 9×10^6.

The effect of compressibility on mass transfer is found to be slightly greater than on friction.

The measurement of the sublimation rate of thin coatings of solids provides a powerful technique of obtaining local friction coefficients, being simpler and of a wider applicability than the method involving force measurements on small floating surface elements.

Mass Transfer, Flow, and Heat Transfer About a Rotating Disk..59—A-107... By E. M. Sparrow, Assoc. Mem. ASME, and J. L. Gregg, Assoc. Mem. ASME, NASA Lewis Research Center, Cleveland, Ohio. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

The effects of mass injection or removal at the surface of a rotating disk on heat transfer and on the flow field about the disk are studied.

Consideration is given to gaseous systems which are composed of either one or two component gases.

Solutions of the equations which govern the hydrodynamics, energy transfer, and mass diffusion have been obtained over the entire range from large suction velocities to large blowing velocities.

Results are given for the velocity, temperature, and mass-fraction distributions, as well as for the heat-transfer, mass-transfer, and torque requirements.

The effects of the mass transfer are discussed in detail.

It is shown that fluid injection sharply decreases the heat transfer at the surface.

Combined Free and Forced-Convection Heat-Generating Laminar Flow Inside Vertical Pipes With Circular Sector Cross Sections..59—A-145... By Pau-Chang Lu, Case Institute of Technology, Cleveland, Ohio. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME —J. Heat Transfer;** available to Oct. 1, 1960).

The free-convection effect in vertical pipe flow has recently become quite significant in a number of engineering applications. The modifier "vertical" here is employed to mean that the longitudinal dimension of the pipe is parallel to the direction of the generating body force, such as gravity or centrifugal force. Combined free and forced-convection, heat-generating laminar flow inside cylindrical pipes with elements parallel to the direction of the generating body force is solved by applying the finite Fourier sine transform and finite Hankel transforms when the cross sections of the pipes are circular sectors. A numerical example is provided to show the effects of various parameters.

Experiments on Heat Transfer From Spheres Including Combined Natural and Forced Convection..59—A-123... By T. Yuge, Tohoku University, Sendai, Japan. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

Recently there has been much interest in heat transfer, mass transfer, and motion of small spheres in studies of combustion, condensation, absorption, and other processes where there are liquid drops or small particles. Many experimental measurements have been made of sphere drag, mass transfer, and heat transfer but, with the exception of sphere drag, the range of Reynolds number was limited.

Previously the author had published experimental heat-transfer data for the Reynolds number range from 1.3×10^5 to 650. In the present investigation the experimental range of Reynolds number was extended from 1.44×10^5 to 3.5 which was extended further by theory to Reynolds numbers near zero.

A further extension of the investigation included here are experimental results for natural convection in the Grashof modulus range from 1 to 10^5 and combined natural and forced convection for cross, opposed, and parallel air flows at Reynolds number below 2535.

The results of these experiments were reported but the details of the investigations at Reynolds numbers above 5.9×10^3 are not included as it is a current study of the influence of turbulence on heat transfer to spheres to be reported later.

Heat Transfer to Freon 12 Near the Critical State in a Natural-Circulation Loop..59—A-142... By J. P. Holman, WADC, Wright-Patterson Air Force Base, Ohio; and J. H. Boggs, Assoc. Mem. ASME, Oklahoma State University, Stillwater, Okla. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

An experimental investigation of heat transfer to Freon 12 in the critical region was conducted. A closed natural-circulation loop was used.

Correlation of the data is presented.

Separate equations are presented for reduced volumes less than one and for reduced volumes greater than one.

The investigation covered a range of temperatures from 150 to 400 F and pressures from 500 to 950 psi.

On Combined Free and Forced Convection in Channels..59—A-77... By L. N. Tao, Assoc. Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to Oct. 1, 1960).

The heat-transfer problems of combined free and forced convection by a fully developed laminar flow in a vertical channel of constant axial wall temperature gradient with or without heat generations are approached by a new method.

By introducing a complex function, which is directly related to the velocity and temperature fields, the coupled momentum and energy equations are readily combinable to a Helmholtz wave equation in the complex domain.

This greatly reduces the complexities of the problems. For illustrations, the cases of flows between parallel plates and in a rectangular channel are treated.

It shows that this method is more direct and powerful than those of previous investigations.

Boiler Feedwater Studies

Closing Our Gaps in Our Knowledge of Steam Sampling..59—A-287... By Henry Phillips, Assoc. Mem. ASME, Foster Wheeler Corporation, New York, N. Y. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

In the determination of steam purity, it is necessary that the collected sample be representative of the main stream. The sample must then be transported in a minimum amount of time to the point of analysis, by suitable tubing, which eliminates contamination. Within the past few years analytical methods have been developed which enable us to determine the purity of a sample of steam with great precision. Equivalent development has not occurred in the actual selection of a sample from a stream. The methods of collecting the sample have been prescribed by the ASME and ASTM organizations. However, little has been done to assure us that the sample collected has the same composition as the steam in the steam pipe from which the sample came. The accuracy of sampling the steam will depend on: (*a*) Nozzle type; (*b*) nozzle location; (*c*) sampling rate; (*d*) operating conditions—pressure, steam velocity, moisture content.

Results of Steam Sampling Nozzle Tests on Evaporator Vapor..59—A-301... By T. A. Miskimen, American Electric Power Service Corporation, New York, N. Y. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Power-plant engineers have been concerned with measuring the purity of the

vapor produced by steam generators. In the ASME Power Test Code and the ASTM standards there are detailed text, drawings, and tables which specify the manner of collecting steam samples. One might think that the sample is as accurately representative as these specifications and drawings are detailed. However, for several years there has been a growing suspicion that this is not so.

These doubts about the sampling specifications have led the Joint Research Council on Boiler Feedwater Studies to encourage exploration of this problem.

This paper describes the study—equipment, test procedures, and results both with multiple-port nozzle and traversing nozzle—and its conclusions.

Controlled carryover was obtained from a power-plant evaporator to explore sampling-nozzle design and location and sample flow rate. It was found that droplets of liquid carryover are separated very quickly from initial, random dispersion in the vapor stream. Because of this, the nozzle location and the sample flow rates are more important to sampling accuracy than is the nozzle design.

Air Pollution Control

Effect of Operating Variables on the Stack Emission From a Modern Power Station Boiler..59—A-308... By G. C. Jefferis, Philadelphia Electric Company, Philadelphia, Pa.; and J. D. Sensenbaugh, Mem. ASME, Combustion Engineering, New York, N. Y. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Emissions from power-plant stacks have long been recognized as contributing to air pollution. It is only in recent years, however, that gaseous effluents, as well as fine particles, are receiving attention. For example, the oxides of nitrogen, which are produced to some extent in all combustion processes, have been found to be involved in the formation of the oxidizing type of smog found on the West Coast.

A series of tests on stack emissions from an oil-fired boiler is described in this paper. The tests were carried out on the emissions from unit No. 1 at Schuylkill Station of the Philadelphia Electric Company. This is a twin-furnace unit of 186-mw capacity. Burners are of the wide-range mechanical atomizing type with a return-oil system.

The effects of the following operating variables on the dust loading, the combustible content of the dust, and the concentration of nitrogen oxides were studied: Windbox air admittance, oil-temperature, burner tilt, excess air, and gas recirculation. Comparisons are made with test results on other units.

Current Status of Air-Pollution Research in the United States..59—A-306... By A. C. Stern, Mem. ASME, Department of Health, Education, and Welfare, Cincinnati, Ohio; and Harry Heimann, Department of Health, Education, and Welfare, Washington, D. C. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Air-pollution research in the United States is substantial. It is financed mainly by governmental funds, and is distributed among 11 governmental, 39 university, and 18 research institutes and private laboratories. The total number of independent projects is approximately 140. Approximately 350 full-time and 400 part-time workers are engaged in the total effort. The laboratory conducting the greatest number of projects is the Robert A. Taft Sanitary Engineering Center of the United States Public Health Service.

Our national air-pollution research effort reached its present activity level only within the past 3 years, the big increment occurring after the enactment in mid-1955 of the Federal Air Pollution Research and Technical Assistance Act. To guide this effort, the United States Public Health Service, which is charged with the responsibility for administering the act and the research funds appropriated thereunder, held national air-pollution research-planning seminars in 1956 and 1958. In 1958 a general conference, attended by a thousand people, reported to the nation the status of the problem and the steps being taken to cope with it.

The major emphasis in air-pollution research in the United States is on studies which relate to the type of air pollution exemplified by Los Angeles "smog." Since many of the factors contributing to this type of air pollution are increasing in all large metropolitan areas in the United States, the results of this research will enhance our understanding of present and potential problems throughout the country.

The Use of Transparent Scale Models in the Design of Dust-Collector and Gas Duct Systems for Coal-Burning Electric-Generating Stations..59—A-305... By E. F. Wolf, Mem. ASME, H. L. Von Hohenleiten, and M. B. Gordon, Baltimore Gas and Electric Company, Baltimore, Md. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

Avoidance of atmospheric pollution has become increasingly important. In the electric-utility industry, in particular, where its customers are its neighbors who insist upon clean air, the importance of dust collectors is increasing.

It has been recognized for many years that the performance of a dust collector is affected by the properties of the ash. It is only in more recent years that the influence of the inlet and exit-duct design on the operation of a collector has been fully recognized. Good gas distribution in the whole gas-duct system and especially in the approach ducts is necessary for the best utilization of the costly fly-ash-collecting equipment.

This paper discusses the use of transparent scale models as an aid in the design of dust collectors and gas-duct systems for coal-burning electric-generating stations. Some of the techniques are described, and specific examples are cited of substantial improvements accomplished by means of the scale-model studies.

Transparent model of flue-gas duct for the first unit of the Herbert A. Wagner Generating Station. Model represents the south half of a symmetrical induced-draft system, which is divided at the exit of the boiler and reunited at the stack as shown (59—A-305).

Fluid Meters

Small-Diameter-Orifice Metering ..59—A-101... By T. J. Filban, Mem. ASME, and W. A. Griffin, Daniel Orifice Fitting Company, Houston, Texas. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

A vast amount of knowledge concerning the behavior of orifice meters in 2-in. sizes and larger has been compiled throughout the years. Industry has employed the orifice meter with confidence because of this compilation of knowledge and its proved reliability.

Of late years there has been an increasing demand for the orifice meter in sizes smaller than 2 in. with tolerances on measurement accuracy comparable to those governing the larger sizes. To guarantee these accuracies it has been necessary to flow calibrate each unit of orifice and meter tube individually. The added expense (sometimes double the cost of the uncalibrated unit) and delay in delivery have been an obvious deterrent to widespread use of these units.

In view of these facts, a re-examination of the possibilities of establishing standard discharge coefficients for the small tubes seemed to be in order. If a general expression for this factor could be developed in much the same fashion as was done for larger tubes, the disadvantages listed would no longer exist. Previous work on this subject by other experimenters had the effect of creating a rather pessimistic view of the feasibility of such a project. After due consideration, however, such a project was initiated in the spring of 1957 at the authors' laboratory facility. A general expression for the flow coefficient in three-quarter and one-inch meters was developed. This paper describes the program, test apparatus, and the procedure for developing the expression.

A Study of Viscosity Effect and Its Compensations on Turbine-Type Flowmeters ..59—A-105... By W. F. Z. Lee and Henning Karlby, Rockwell Manufacturing Company, Pittsburgh, Pa. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

An analysis of the viscosity effect on meter accuracy of an axial-flow turbine-type flowmeter is formulated by the use of physical reasoning and experimental evidence.

This analysis indicates methods of compensating for the effect of viscosity on meter accuracy.

One method of compensating for viscosity is analyzed and design criteria are developed for constructing a viscosity compensator.

Test results of a turbine meter, before and after installation of a viscosity compensator, are presented for comparison with the results determined from analysis.

The Quadrant Edge Orifice—A Fluid Meter for Low Reynolds Number..59—A-140... By M. Bogema, Mem. ASME, and P. L. Monkmeyer, Cornell University, Ithaca, N.Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Oct. 1, 1960).

Tests have been conducted to determine the usefulness of the quadrant edge orifice as a fluid-metering device for low Reynolds number flow.

As a result of numerous laboratory tests to determine the behavior of the discharge coefficient with changing Reynolds number, the following are discussed: The range of constant discharge coefficient, reproducibility of orifice plates, diameter ratio effects, upstream roughness effects, reinstallation effects, and effects of pressure tap location.

Human Factors Engineering

Typical prosthesis for an above-elbow amputee. Major advances in this area can be made through basic research in biology and in surgery and through development of auxiliary power and co-ordinate sensory system (59—A-184).

Some Human Factors Considerations in the Development of Upper Extremity Prostheses..59—A-184... By Anthony Staros, VA Prosthetics Center, New York, N. Y. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

The normal upper extremity—shoulder, arm, forearm, and hand—is a complex neuromuscular mechanism whose capability may be studied for use in the design of a mechanical system for replacement when functional and structural losses occur.

Biomechanical methods are used to study the performance and capability of the normal upper extremity. After establishing convenient reference planes and co-ordinates, ranges of motions and forces developed in various directions by individual segments and combinations of segments are measured using simple laboratory goniometers and force gages. Performances of normals in daily living activities are observed. Sensory control and how this human factor may affect performance and, later, prosthetic design are studied.

Clinical information obtained from amputees and paralytics points up additional criteria, as the wearers' experiences with materials, hardware, maintenance, and so on, are indeed critical to prosthesis design, construction, and fittings.

In general, ingenious compromises are now employed to bring about some functional restoration in a prosthesis or brace.

This paper presents generalized considerations on the normal upper extremity, amputation and loss of function, and the replacement problem.

Some Considerations in the Design of Hand Substitutes..59—A-262... By M. J. Fletcher, Colonel, U. S. Army Prosthetics Research Laboratory, Walter Reed Army Medical Center, Washington, D. C. 1959 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1960).

By virtue of its elaborate structural organization, and also because of its inherent sensory-motor connections with the conscious and subconscious manifestations of the brain, the human hand is one of the most complicated and widely versatile of all mechanisms. So indispensable is it to all kinds of human activity that its loss is acutely felt both physically and mentally. Yet its replacement by inanimate devices is a

particularly exacting task not readily accomplished even with the combined skills of a number of disciplines, including engineering.

Described in this paper are some of the attributes that establish the broad requirements of any "satisfactory" hand substitute.

After a brief review of the history of hand prosthetics and an analysis of certain unavoidable limitations, this paper outlines the design criteria laid down in a renewed research effort stemming from World War II and describes the development, within the stated restrictions, of an improved "voluntary-closing" artificial hand and corresponding split hook. Included at the end is a brief summary of the present status of the art of hand prosthetics, where it is pointed out that attempts at actual simulation of the hand are less likely to be profitable than are efforts aimed at comparatively simple gains in contrived performance.

Applied Mechanics

Elastic Equilibrium of a Plate With a Reinforced Elliptical Hole..59—A-45... By Eugene Levin, Assoc. Mem. ASME, The Rand Corporation, Santa Monica, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

An infinite thin plate with an elliptical hole reinforced by a confocal elliptical ring is subjected to loads in the plane.

A solution to the generalized plane-stress problem is obtained using the complex variable techniques of Muskhelishvili.

The result is presented in a form well suited to evaluation by digital computers.

Specialization to a circular hole with a negligibly thin reinforcement is shown to be in agreement with results obtained by other authors.

Stresses in a Slab Having a Spherical Cavity Under Circular Bending..59—A-64... By Chih-Bing Ling and Chen-Peng Tsai, Aeronautical Research Laboratory, Taichung, Taiwan, China. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

In a previous paper the senior author presented an analytic solution for the stresses in a stretched slab of infinite size having a symmetrically located spherical cavity. In this paper the stresses in a like slab when it is under circular bending around its edge are investigated. Likewise, the theory of symmetrical strain for solids of revolution is used in the analysis. The stress function in question is constructed by using two series of periodic biharmonic functions and a biharmonic integral. The series of biharmonic functions have been defined in the previous paper. However, unlike the previous solution for a stretched slab, here the stress function is necessarily even with respect to the mid-plane of the slab by symmetry.

The solution is illustrated by numerical examples for two radii of the cavity. In particular, the maximum stresses in the slab are computed to show the effect of the cavity on the stresses in the slab.

A Method of Solution for the Elastic Quarter-Plane..59—A-52... By M. Hetényi, Mem. ASME, Northwestern University, Evanston, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

It is shown in this paper that for given loads on the elastic quarter-plane the prescribed boundary conditions can be fulfilled by repeated superposition of known solutions for the elastic half-plane.

This leads to a sequence of infinite integrals of a simple recursion pattern.

The solution is exact, since the sequence may be continued to obtain any required accuracy.

Solutions are derived in this manner for three types of boundary loads: (*a*) Concentrated normal force, (*b*) concentrated tangential force, and (*c*) partially distributed uniform loading.

Transient Thermal Stresses in a Semi-Infinite Slab..59—A-63... By W. Jaunzemis, The Pennsylvania State University, University Park, Pa.; and E. Sternberg, Assoc. Mem. ASME, Brown University, Providence, R. I. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

This investigation is concerned with the transient temperature and thermal-stress distribution generated in a semi-infinite slab if a finite segment of its edge is subjected to a sudden uniform change in temperature.

The slab is supposed to be free from external loads and its faces are assumed to be insulated.

Exact solutions in series form are obtained both for the heat-conduction problem and for the associated thermoelastic problem. The latter is treated quasi-statically within the classical two-dimensional theory of elasticity.

The thermal stresses appropriate to the generalized plane-stress solution vanish identically in the limit as time tends to infinity.

The space and time dependence of these stresses is examined in some detail with a view toward tracing the evolution of this well-known, steady-state degeneracy.

Finally, the results corresponding to an instantaneous heating or cooling of a portion of the boundary are used to study the effect upon the stresses of gradual changes in the surface temperature.

A Unified Criterion for the Degree of Constraint of Plane Kinematic Chains..59—A-34... By B. Paul, Assoc. Mem. ASME, Brown University, Providence, R. I. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The degree of freedom or overconstraint of plane kinematic chains is determined by means of an analysis of independent loops.

It is shown how the independent loops of a system may be identified and how they may be used to recognize certain special cases which do not fit into the framework of so-called "general formulas."

The independent loops may also be used to systematically formulate the governing kinematic equations of a system. It is shown that the equations so formulated are in general sufficient to solve for all unknown velocities and accelerations.

Approximate Synthesis of Spatial Linkages..59—A-24... By J. Denavit, Assoc. Mem. ASME, and R. S. Hartenberg, Mem. ASME, Northwestern University, Evanston, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME-J. Appl. Mech.**; available to Oct. 1, 1960).

Freudenstein's approximate synthesis of planar four-bar linkages is generalized to spatial linkages, and the conditions under which this generalization is applicable are expressed.

Three cases of synthesis of spatial linkages to generate functions of one variable between nonparallel axes are considered in detail: (*a*) The spherical four-bar linkage; (*b*) a variation of the four-bar linkage in which two turning pairs are replaced by ball-and-socket joints, a linkage which may be designed to generate arbitrary functions with up to seven accuracy points; and (*c*) a second variation of the four-bar linkage where three turning pairs are replaced by cylinder pairs, a linkage capable of being designed to generate a variable-pitch helical motion with three accuracy points.

A Theory of Lubrication With Turbulent Flow and Its Application to Slider Bearings..59—A-26... By L. N. Tao, Assoc. Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The governing equation of turbulent lubrication in three dimensions, equivalent to the Reynolds equation of laminar lubrication, is derived.

The problem of a slider bearing with no side leakage is then analyzed. An exact solution is found in closed form.

Bearing characteristics are also established. It is found that the Reynolds number is an important parameter in the problem of turbulent lubrication.

Furthermore, it is shown that the laminar lubrication may be considered as the special case of the present study. A numerical example is also included.

On the Annular Damper for a Freely Processing Gyroscope..59—A-44... By G. F. Carrier, Mem. ASME, Harvard University, Cambridge, Mass.; and J. W. Miles, University of California, Los Angeles, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The dynamics of a damper that has been used to eliminate the free precession of flying, spinning objects are analyzed.

There are three regimes in which the details of the mechanisms by which the viscous fluid dissipates the precessional energy differ markedly, and the fluid motion and energy-dissipation rate are described quantitatively for each regime.

The Motion and Loading of a Hinged Ramp Which Supports a Sliding Mass..59—A-85... By B. Saelman, Lockheed Aircraft Corporation, Burbank, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

Equations of motion of a hinged ramp supporting a sliding mass, which moves at constant velocity, are derived; these are shown to have no closed solution when the ramp is spring supported or when the cylinder force is proportional to the square of the velocity.

For small velocities of the sliding mass the Coriolis term may be neglected and a good approximation to the solution of the equations is obtained by means of the Madelung transformation.

The solutions by special methods are compared to the solutions obtained by standard numerical methods.

Dominance of Shear Stresses in Early Stages of Impulsive Motion of Beams..59—A-60... By H. H. Bleich, Mem. ASME, and R. Shaw, Columbia University, New York, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

In order to compare the magnitude of bending stresses and shear stresses in beams under the action of impulsive forces, the values of these stresses are determined from the known differential equations for the Timoshenko beam.

It is found that in the early stages, soon after the initiation of the motion, the shear stresses are of much larger magnitude than the bending stresses.

This result indicates that for sufficiently large initial velocities first yielding will be in shear, a matter of consequence in plastic analysis.

On the Elastic Bending of Columns Due to Dynamic Axial Forces Including Effects of Axial Inertia..59—A-25... By Eugene Sevin, Mem. ASME, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

This study is concerned with the influence of axial inertia upon the elastic bending motion of initially slightly curved columns acted on by time-dependent axial forces. The equations of motion include both axial inertia and nonlinear strain terms.

Numerical solutions were obtained for a similar problem previously studied by Hoff but in which axial-inertia effects were neglected; i.e., the problem of a simply supported column initially bent in the shape of a half sine wave and loaded by displacing one end axially at a constant rate.

The range of solutions pertains to conventional structural compression members (slenderness ratios less than 150), and to minimum rates of loading compatible with elastic response of common engineering materials.

This study suggests that axial-inertia effects are of secondary importance in so far as the gross elastic response of conventional structural columns is concerned.

Plastic-Wave Propagation Effects in Transverse Impact of Membranes..59—A-128... By B. Karunes, Mem. ASME, and E. T. Onat, Assoc. Mem. ASME, Brown University, Providence, R. I. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The paper is concerned with the plane motion of a rigid-strain-hardening membrane attached to two parallel fixed supports. The membrane is subjected to a uniformly distributed transverse impulse and the subsequent motion of the membrane is to be determined with the particular emphasis on the variation of thickness in the final deflected shape.

It is first shown that two essentially different initial modes of deformation exist depending on the average rate of hardening.

For both modes, the analysis can be based on two types of waves of discontinuity until the moment when the compressive membrane forces occur in the middle region of the membrane.

The presence of compressive forces will generally preclude the existence of a unique solution for further motion. The bending rigidity will probably have to be included into the analysis in order to obtain a unique solution. However, for the technically important rates of hardening and velocities, the kinetic energy of the membrane at the moment of occurrence of compressive forces is small compared with the initial energy, so that significant information could be obtained from the present analysis about the variation of thickness and hardening throughout the membrane.

The Elastic-Plastic Response of Thin Spherical Shells to Internal Blast Loading..59—A-95... By W. E. Baker, Mem. ASME, Aberdeen Proving Ground, Md. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

In this paper, the theory is developed for the elastic-plastic response of a thin spherical shell to spherically symmetric internal transient pressure loading.

Analytic solutions are obtained to the linear, small-deflection equations of motion for shell materials which exhibit various degrees of strain-hardening.

Numerical solutions obtained by digital computers are also presented for the equations for large deflections obtained by accounting for shell thinning and increase in radius during deformation.

The theory is compared with experiment, and is shown to be in good agreement.

On a Dynamical Saint Venant Principle..59—A-61... By B. A. Boley, Columbia University, New York, N. Y. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The dynamic behavior of a simple mechanical model composed of two Timoshenko beams connected by springs is studied.

The accuracy of a quasi-static solution and of Saint Venant's principle is studied for various rates of load application.

Classical Normal Modes in Damped Linear Dynamic Systems..59—A-62... By T. K. Caughey, Pasadena, Calif. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

An analysis of the conditions under which a damped linear system possesses classical normal modes is presented.

It is shown that a necessary and sufficient condition for the existence of classical normal modes is that the damping matrix be diagonalized by the same transformation that uncouples the undamped systems.

Sufficient though not necessary conditions on the damping matrix are developed, and it is shown that Rayleigh's solution is a special case of the present theory.

Possible Similarity Solutions for Laminar Free Convection on Vertical Plates and Cylinders..59—A-86... By Kwang-Tzu Yang, Assoc. Mem. ASME, University of Notre Dame, Notre Dame, Ind. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1959).

In this paper, a study is made of the unsteady laminar boundary-layer equations for free convection on vertical plates and cylinders to establish necessary and sufficient conditions under which similarity solutions are possible.

On the basis of these conditions, all possible cases are derived, including those for unsteady conditions.

It is found that the available similarity solutions in the literature have essentially covered all steady cases, except that the present analysis shows that somewhat more general conditions may also be taken in account.

Hydrodynamic Entrance Lengths for Incompressible Laminar Flow in Rectangular Ducts..59—A-82... By L. S. Han, The Ohio State University, Columbus, Ohio. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

The problem of determining the hydrodynamic entrance length in a rectangular channel is solved by the method of linearizing the Navier-Stokes equation.

The resulting equation is regarded as an equation to generate a mathematical expression for the axial velocity in the entire region, making smooth transition from a uniform profile to the fully developed one.

From this expression, the entrance length, defined as where 99 per cent of the fully developed center-line velocity is attained, is calculated for channels of six aspect ratios.

The pressure drops are also calculated and presented herein.

A comparison is made with the limited amount of experimental and theoretical data.

Steady-State Undamped Vibrations of a Class of Nonlinear Discrete Systems.. 59—A-67... By P. R. Sethna, University of Minnesota, Minneapolis, Minn. 1959 ASME Annual Meeting paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to Oct. 1, 1960).

Steady-state vibrations of a class of nonlinear discrete systems with an arbitrary number of degrees of freedom are studied.

The co-ordinates of the system are first transformed to the principal co-ordinates corresponding to the linear part of the system.

A perturbation scheme is used to obtain the solutions.

Some special effects of the ratios of the linear natural frequencies on the qualitative nature of the solutions are demonstrated.

Solutions are obtained for some specific problems and the results are checked against those obtained from an analog-type computer.

ASME TRANSACTIONS

The January, 1960, issue of the Transactions of the ASME—*Journal of Engineering for Power* (available at $1.50 per copy to ASME Members, $3 to nonmembers)—contains the following:

Journal of
ENGINEERING FOR POWER

Volume 82 • Series A • Number 1

1 Development of a Three-Stage Liquid-Cooled Gas Turbine, by Sumner Alpert, R. E. Grey, and W. O. Flaschar. (59—GTP-1)

10 Effect of Ambient and Fuel Pressure on Spray Drop Size, by S. M. DeCorso. (59—GTP-3)

19 Presentation of a Blade-Design Method for Axial-Flow Turbines, Including Design and Test Results of a Typical Axial-Flow Stage, by F. Baumgartner and R. Amsler. (59—GTP-4)

27 The Basic Heat Transfer and Flow Friction Characteristics of Six Compact High-Performance Heat Transfer Surfaces, by W. M. Kays. (59—GTP-2)

35 Metallurgical Evaluation of Superheater-Tube Alloys After Six-Months' Exposure at Temperatures of 1100 to 1500 F, by C. L. Clark, J. J. B. Rutherford, A. B. Wilder, and M. A. Cordovi. (59—Pwr-1)

68 Blast-Furnace-Gas Cleaning for Iron and Ferromanganese Production, by J. S. Mackay and J. F. Kearns.

73 Influence Coefficients for Open-Crown Hemispheres, by G. D. Galletly. (59—SA-4)

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59—A-48	59—A-107	59—A-262
59—A-51	59—A-113	59—A-263
59—A-52	59—A-118	59—A-287
59—A-53	59—A-123	59—A-301
59—A-54	59—A-128	59—A-305
59—A-55	59—A-134	59—A-306
59—A-60	59—A-137	59—A-308
59—A-61	59—A-140	59—A-316
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COMMENTS ON PAPERS

Technical Personnel—Evaluation and Development

Comment by T. A. Abbott[1]

THE author of this paper[2] has described an approach to a difficult problem. There is not any one best method for evaluating and developing technical people, even within a single organization. The process of evaluation is inherently subjective and, in a large organization, can only be as effective as the astuteness of the first-line supervisors permit.

The only effective approach to accomplishing the objective is to do everything possible to improve the supervisory skills of the first-line supervisors. If they are adept, any paperwork system can be made to work. In this case, there is considerable merit to changing the system periodically. This serves to emphasize continued management interest in the development of its technical personnel, and keeps the supervisory staff alert to the potentialities of their people. New techniques and thinking should always be brought to the attention of the supervisory staff when warranted.

Providing written descriptions of job duties and responsibilities upon which the employee and his supervisor can agree has great merit. To do this well is a major chore, but it should pay off in improved efficiency and morale.

Comment by Carl E. Dahlquist[3]

Several important facts are to be gained from this paper.[2] One is that it will force management to review job positions and appraisals. When a company first starts such a program, many things will be found such as overlapping duties, conflicts in responsibilities, underpayment, overpayment, poor placement, lack of development programs, and the like. Where the program is pursued, parallel with other firms in the area, many interesting developments are possible. It is certainly true that examining into the detail make-up of each job can be most illuminating and instructive. Such a review of all jobs will prove beneficial even if the program is not more comprehensive.

The idea of insisting supervisors take stock of the man being rated is tantamount to rating himself as to what he has done to help that man. He can clearly see, if he is honest, his own good points and shortcomings as represented in his personnel. No matter what else he may be, a supervisor is fundamentally a teacher and coach. It should be most interesting to a supervisor to know he is part of such a scheme and his own position is subject to the same analysis. I would like to suggest that the author consider having his supervisor analyzed by rating by some of the men under him. Personnel are cognizant of shortcomings in their supervisors.

We have found that the author is quite right in his statement regarding sincerity and honesty in rating by supervisors. We have found that some of our men consistently rate each of their men high while others always rate conservatively. We adopted a procedure of rating each man as to how he performed after each assignment. As our men are assigned to various supervisors according to our work load, we have an opportunity to run a multiple check on each man. We find that our supervisors use these ratings when choosing personnel for assignment more than the man's qualification record. Our greatest problem is to continue our efforts to help the man overcome his shortcomings and qualify for something better. This, I think, is representative. We are certain that our program leads better men to us, since the better men realize a definite program is a real help to them.

There should be no doubt that a systematic approach to the matters of the paper consistently will give better results than where such a program is lacking.

Author's Closure

Mr. Abbott's comments on the astuteness of the first-line supervisor and the significance of concentrating training efforts on him for success of any such program certainly are pertinent. We also heartily agree that any effective program must be dynamic; periodic re-examination of the program is a must for continued effectiveness. Similarly, position guides and job descriptions must be reviewed at least annually.

Most of Mr. Dahlquist's comments are in the category of "one Republican talking to another." However, comment on two specific points may be worth while. Mr. Dahlquist suggests having supervisors rated by subordinates. This was tried in one department a few years ago with something less than positive results. Perhaps the poor reactions resulted from the particular personalities involved, and hence should not be condemned by the "single set of data." We prefer to believe that desired results may be achieved by an informal approach as a part of a good performance review. It behooves the good supervisor—and it must apply to an effective performance review interviewer—to seek comment from the subordinates on their working relationship, particularly on suggestions for how the supervisor could improve the relationship. We would not expect the subordinate to bare his every feeling, but it does force him to take a positive and constructive approach.

We have not attempted the rating of the individual at the completion of each assignment as described by Mr. Dahlquist. This system has merit over the periodic basis which we use, since it can be more closely related to specific

[1] Manager, Engineering Administration, Standard Oil Company of Indiana, Chicago, Ill. Mem. ASME.

[2] W. E. Alexander, "Evaluation and Development of Technical Personnel," MECHANICAL ENGINEERING, vol. 81, April, 1959, pp. 67–68.

[3] Chief engineer, Sterns-Roger Manufacturing Company, Denver, Colo.

performance while fresh in mind, and provides multiple appraisals. When reduced to routine procedural practice, we would expect to see even better reception to performance reviews and faster, more effective results. It would seem possible that one adverse factor could be the frustration of the subordinate by attempting simultaneous pursuit of two different courses of corrective action on a single performance factor suggested to him independently by two supervisors with divergent views and opinions on the better corrective actions required.

W. E. Alexander.[4]

[4] Assitant Director of Engineering, Plastics Division, Monsanto Chemical Company, Texas City, Texas.

Graphitization Failures in Piping

Comment by R. W. Emerson[5]

THIS paper[6] represents another chapter in the story of graphitization. To those utilities who are still operating with carbon-moly piping, this writer is sure it is hoped this chapter will be the last.

In January, 1959, it was 16 years that the Springdale failure occurred, and in March of 1943 I was privileged to speak before utility-operating personnel representing the major utilities throughout the United States.

Prior to 1943, the likelihood of the occurrence of graphitization to the extent found in a low alloy steel containing carbon in the range of only 0.10–0.15 per cent would have been considered highly implausible, if not impossible, by the foremost metallurgists in the United States.

In fact, needless to say there were, after this presentation, many skeptics in the 1943 audience, including several reputable metallurgists well known to the power industry. I am sure there are people here today who will bear me out in this statement.

It was the feeling of a few that a highly theoretical approach was developed to possibly camouflage improper fabrication techniques employed on the Springdale piping.

The problem as presented to the West Penn Power Company appeared to be potentially basic to all operating utilities who were using carbon-moly pipe at an operating steam temperature of 900 F or higher. With this information at hand, West Penn Power Company personnel suggested and arranged the meeting 16 years ago in order that representatives of all the major utilities might obtain first-hand information as to the basic cause for failure, and make arrangements for the investigation of other steam lines operating at temperatures comparable to those at the Springdale Station.

[5] Assistant to the president, Pittsburgh Piping and Equipment Company, Pittsburgh, Pa. Mem. ASME.

[6] J. B. Nuchols and J. R. McGuffey, "Graphitization Failures in Piping," MECHANICAL ENGINEERING, vol. 81, May, 1959, pp. 43–45.

The general principles and concepts put forth as the cause of the Springdale failure, in 1943, are still valid.

With regard to this paper,[6] it cannot be overemphasized that the condition of one joint with respect to graphitization bears no relationship to the condition which may be found in another joint even though they appear on the surface to be identical.

One question I would like to raise concerns the normalizing of graphitized pipe joints. Experiments on normalizing severely graphitized joints were made in 1943 with the thought that rewelding might be unnecessary at Springdale. We were successful in placing the graphite in solution, although we found that no substantial improvement was made on the weld heat-affected zone ductility. Wonder if the authors would care to elaborate on this point?

Comment by I. A. Rohrig[7]

The Union Carbide Nuclear Company is to be commended for its forthrightness in sharing with the steam-electric power-generation industry its experience in graphitization failures in carbon-molybdenum high-temperature steam piping. The authors' account[6] of two failures in the same plant is a solemn reminder that, although the anxiety and concern precipitated by the Springdale failure in 1943 have subsided generally, concern for this problem should not disappear.

The graphitization-rehabilitation program of The Detroit Edison Company was quite similar to that of the authors' with the exception that in 1948 Detroit Edison began rewelding and heat-treating welded joints that showed significant graphitization and in 1951 began replacement of tees, wyes, bends, and manifolds. The number of welded joints that have received attention in our program is shown in Table 1. Figs. 1 and 2 show schematically the areas replaced in the piping at Delray and Conners Creek Power Plants. The replacement was made with ASTM, A-280 material, 0.75 chromium—0.50 molybdenum, now known as Grade P-2, A-335. The replacement of tees, wyes,

[7] Materials engineer, General Engineering Department, The Detroit Edison Company, Detroit, Mich. Mem. ASME.

Table 1

GRAPHITIZATION REHABILITATION PROGRAM

PLANT	JOINTS SAMPLED	JOINTS RE-WELDED	JOINTS HEAT-TREATED
CONNERS CREEK	98	274	311
DELRAY	72	122	176
MARYSVILLE	14	—	106
TOTAL	184	396	593

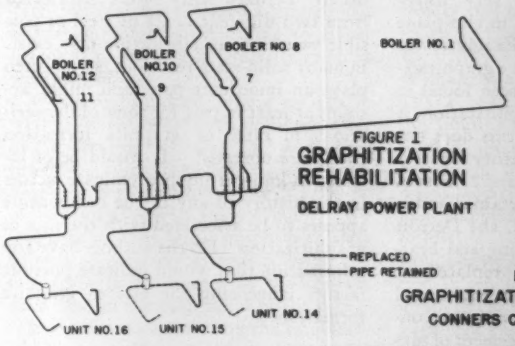

FIGURE 1
GRAPHITIZATION REHABILITATION
DELRAY POWER PLANT

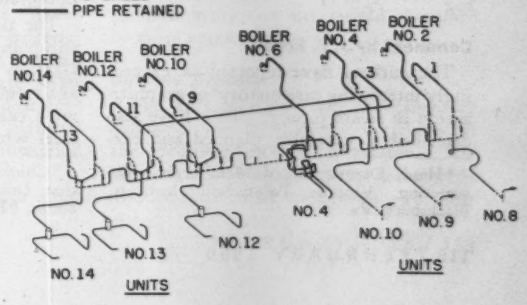

FIGURE 2
GRAPHITIZATION REHABILITATION
CONNERS CREEK POWER PLANT

bends, and manifolds was decided on because of the practical difficulty of reconditioning such complicated welded structures. Furthermore, complete replacement of such items was quicker, and nearly as economical as any method of reconditioning and, furthermore, permanently cured such vulnerable areas. Particular attention was given to completing the rehabilitation, once started, on any scheduled section of the piping. Some action was taken regarding each joint; this prevented the situation whereby certain joints could be left undone.

In 1958 a program of resampling was begun. Welded joints that had been flame-gouged, rewelded, and normalized approximately nine years earlier were resampled. In five carbon-molybdenum welded joints thus sampled, only traces of graphite have been found in the weld-affected area. Examinations have been made also of the zone of the pipe that was in the temperature range of 1000 to 1300 F during the normalizing operation. This was done by removing samples 6, 8, and 10 in. away from the weld. The reason for taking samples from the pipe adjacent to the weld was that the objection has been stated that normalizing at 1700 F merely transferred the heat-affected zone from the weld to a new location near the edge of the normalized zone. Samples taken from several joints indicate that no such sensitized zone occurs as a result of normalizing; only scattered, nodular graphite has been found.

It should be pointed out that in rewelding and normalizing, the pipe was thoroughly braced so that there was no possibility of movement. Any movement during normalizing very likely would be expected to result in slip-plane type of graphitization. Examinations have been made for slip-plane graphitization but thus far none has been found in our piping. Random graphitization is present in the piping, but this does not make the material unsatisfactory for service. As indicated in Figs. 1 and 2, most of the original pipe has been retained and is still in service. In general, the Detroit Edison program of rewelding and heat-treatment combined with replacement of certain sections has been adequate and represents a substantial saving as contrasted with complete replacement of piping.

Comment by J. F. Eckel[8]

The authors have reported an exceedingly interesting case history[6] of graphitization in steam piping. They have also described a carefully planned and executed program of inspection, repair, and replacement. This program operated satisfactorily with a high degree of confidence up to the time of the major failures. It is realized, of course, that such a program cannot cover a steam-piping system in its entirety and therefore must operate to provide optimum coverage. It then must become a program of sampling, particularly at points which are suspect.

In reading this paper[6] it is noted that the rate of graphitization varies from one location to another in the system. Whether this can be correlated with location in the system or is dependent upon prior history of each section of the system is not apparent. This point is of particular interest since it demonstrates the need for more detailed knowledge on the kinetics of graphite nucleation and growth in steels.

That the carbon-molybdenum steel employed in the Oak Ridge Gaseous Diffusion Plant Power Station steam piping is subject to graphitization is well demonstrated. Insufficient information is available concerning effects of such factors as thermal and mechanical history, segregation, operating conditions, and so on, on rates of graphite formation. There is ample evidence presented in this paper[6] to indicate that the rate of graphite formation varies even in similar components. For instance, a comparison is made between the graphite found in the 12-in. boiler lead that failed and a comparable fitting at the other end of the header. The question naturally arises: In what respect do these two seemingly similar components differ that would cause rapid graphite formation in one and not in the other? Perhaps they were fabricated from two different heats of steel or possible variations in fabrication may exist. In many solid-state reactions, stress often plays an important part, and might account at least in part for some of the variations in rates of graphite formation that were observed. It would be of interest to know if any predominate factors in the history of any of the components appears to be associated with the rate of graphitization. Do the authors have any information that would indicate possible factors influencing the rate of graphite formation?

Comment by A. B. Wilder[9]

The occurrence of nodular-chain and slip-plane graphite in the Oak Ridge Gaseous Diffusion Plant Power Station again emphasizes the problems associated with carbon—$^1/_2$ per cent molybdenum steel when exposed for long periods of time at temperatures exceeding 850 F. This grade of steel, particularly when deoxidized with large quantities of aluminum is susceptible to graphitization. The most practical solution to a problem of this type is to replace the piping. The authors are to be commended for presenting this paper[6] because it will serve as a reminder for some who may be inexperienced with the graphitization problem.

Normalizing a welded joint will result in recrystallization of the weld heat-affected zone and solution of most of the graphite. However, a temperature-transition zone in the body of the pipe exists after normalizing the weld. A residue also remains after dissolving the graphite. This residue will appreciably reduce ductility of the welded joint. Normalizing is, therefore, not recommended, particularly after graphitization has been encountered.

Comment by H. M. Soldan[10] and E. J. Siegel[11]

The authors have prepared an excellent report on the failures due to graphitization of carbon-moly pipe in high-pressure-temperature service at the Oak Ridge Gaseous Diffusion Plant Power Station.

No mention is made of ASTM material specifications or the heat-treatment given to the piping or welded joints. From the initial date, we would assume that piping was made according to Specification A206, in which case we would not be surprised that more than mild graphitization was found in 50,000 hr of operation. This is consistent with our examinations which also indicate that, after this length of time, graphitization in this type of material can proceed quite rapidly, and eventually reach the same degree as that obtained in much less time in piping made to the earlier Specification A158, and appears to have a more deleterious effect. This deleterious effect results from graphite in stringer form along the grain boundaries, Fig. 1; whereas, in the old specification piping, aside from a few instances of chain graphitization, the graphite appeared in large, more or less scattered nodules.

We also note that an attempt was made to restore graphitized joints by normalizing at 1700 F. Investigations made in 1944 indicated that this was not effective, particularly in joints where graphitization had progressed to any degree. At this time, several recom-

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[10] Senior Engineer, Electric Engineering Department, Public Service Electric and Gas Company, Newark, N. J. Mem. ASME.

[11] Engineer, Electric Engineering Department, Public Service Electric and Gas Company, Newark, N. J. Mem. ASME.

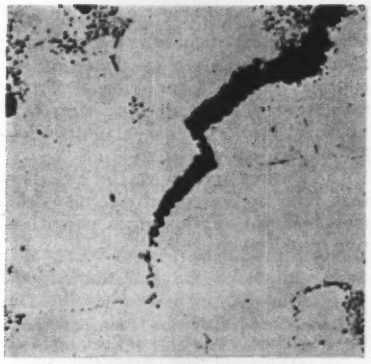


Fig. 1 Graphitization in contact zone of new specification pipe (A206) weld after 90,000-hr service; 500×

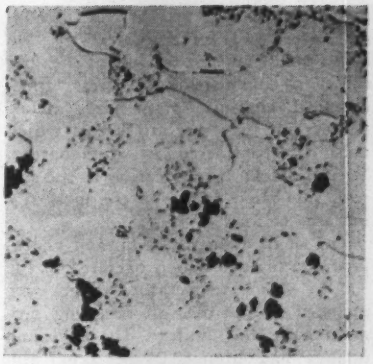


Fig. 2 Weld-contact zone in old specification (Rivesville) pipe (A158) before rewelding (after 25,000-hr prior service; 500×

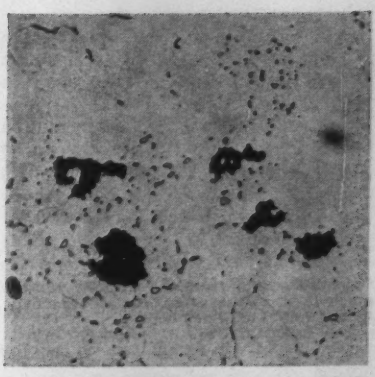


Fig. 3 Weld-contact zone in same pipe (A158) rewelded with 1300 F, 4-hr postheat, after 105,000 hr of additional service; 500×

mendations were studied by accelerated testing at our Maplewood Laboratory, and the results indicated the following:

(*a*) A 1300 F, 4-hr postheat-treatment would inhibit the formation of graphite in the contact zone of the weld.

(*b*) A 1750 F postheat-treatment applied to new welds would inhibit the formation of graphite.

(*c*) A 1750 F normalizing heat-treatment applied to the base metal prior to welding would deter the formation of graphite.

(*d*) Normalizing welds, which had graphitized to any considerable degree at temperatures even as high as 2000 F, would put the graphite in the contact zone back into solution but left voids containing unknown constituents, which upon tests was shown to impair the service life of the material.

We are surprised to find serious graphite developing in connections as small as 2 in. in size. Perhaps, this can be explained by the abnormally high operating temperature, which is not stated. We have never experienced graphitization to any degree in anything smaller than 6-in. pipe. Our experience indicates that 950 F, heavy wall piping, in highly stressed areas, is the most susceptive to rapid graphitization, but the susceptibility of some sections of the piping to more rapid development of graphitization than others has never been otherwise satisfactorily explained.

Carbon-molybdenum steel pipe to ASTM Specification A158 was first placed in commercial operation in our system in 1938, for service conditions of 1250 psi at 950 F normal, 1000 F maximum. Subsequently, CMo pipe to ASTM Specification A206, was used in our piping systems in three additional installations operating at similar conditions (1940–1943). Welded joints received a 1250-F stress relief for 1 hr per in. of thickness after welding.

In 1943, following the failure at the West Penn Power Company's Springdale Station, an investigation of welded joints in our CMo piping revealed that graphitization had progressed to a point where remedial measures were required. In 1944 operating steam temperatures were limited to 950 F maximum.

In our rehabilitation program, joints were inspected and rewelded during regular overhaul outage times of the units, and all rewelded joints were given a 1300 F, 4-hr stabilization heat-treatment. We have rewelded 193 out of 243 inspected joints and have replaced certain bends in carbon-moly pipe which were improperly heat-treated during fabrication, and in which graphitization developed in Lüder lines or shear planes which resulted from improper fabrication. To date, we have not replaced a single piece of carbon-molybdenum piping to either specification because of graphitization at weldments.

We have examined piping originally welded with 1250-F stress relief after 25,000 service hr, Fig. 2, and after rewelding with the 1300 F, 4-hr postheat-treatment and following 105,000 hr of additional service Figs. 3 and 4. We find that to date, while graphite appears to some degree as scattered nodules, the formation is no greater in the contact zone than in the base metal of the pipe.

In studies made for us by the Engineering Research Institute of the University of Michigan in 1951 and 1958, stress-rupture properties of CMo pipe material removed after 75,054 and 93,144 hr at an average temperature of 913 F were better than predicted for new pipe. Additional tests now being conducted on material having 150,000-hr service also show good properties.

Summarizing, it would appear that

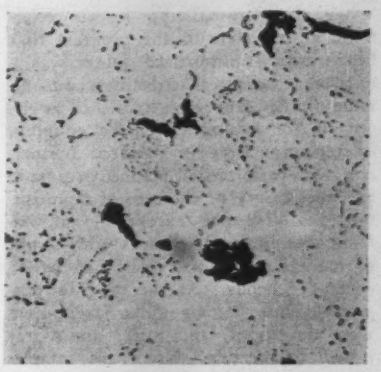


Fig. 4 Parent metal (A158) at rewelded joint after 105,000 hr of additional service; 500×

had sufficient metallurgical knowledge concerning proper heat-treatment been available, at the time of the installation of this carbon-moly piping, graphitization of this material in high-temperature steam service would not have presented the unfortunate picture it did. Material normalized at 1750 F and/or receiving a 1300 F, 4-hr postheat-treatment following welding has been satisfactory for the service intended. This contention is supported in several instances where welds adjacent to bends, which welds had received a furnace heat-treatment following bending and upon examination, showed no evidence of graphitization in service. The additions of chromium to carbon-moly steel in amounts of 1 per cent and upward has been shown to inhibit the formation of graphite; and for new work, its use would therefore be more appropriate.

Authors' Closure

The authors appreciate the extensive comments furnished by the reviewers on the problem of graphitization. The answers to their questions have been divided into three categories: 1 Nor-

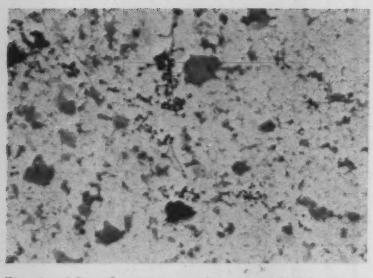


Fig. 1 After four years the graphite had reprecipitated to the extent that the ductility dropped to 45 to 60-deg bends

malizing practice; 2 factors affecting the rate of graphitization; 3 small diameter pipe.

Regarding normalizing, it was recognized at the start of the program that heat-treating graphitized joints was a temporary measure; accordingly, a maximum of five years was established as the criteria for resampling, flame gouging, or replacement. No repeated normalizing was performed or planned because of the uncertainty of the rate of reprecipitation. With one exception, normalizing was limited to joints with slight to moderate graphite as shown by 45 to 80-deg bends. As the program progressed and flame-gouging techniques were developed, the lower limit was raised to 55 deg. Numerous samples were removed immediately after normalizing and during subsequent yearly outages to evaluate by ductility and microstructure the effectiveness of the heat-treatment. Normalizing at 1700 F for two to four hr was quite effective as the ductility was restored to 90-deg bends and no voids were detectable in the heat-affected zone. After four years, the graphite had reprecipitated to the extent that the ductility dropped to 45 to 60-deg bends (see Fig. 1). One attempt at normalizing a severely graphitized joint with a 15-deg bend confirmed Mr. Soldan's findings as no significant ductility could be restored and the structure contained voids; this joint was flame gouged and rewelded before placing the system in operation. Normalizing was performed in a most conservative manner so that it is the authors' opinion it provided adequate protection until flame gouging or replacement was required.

Considerable work was performed on the factors affecting the rate of graphitization. Unfortunately, no additional information is available on the history of the fabrication practices, welding, and heat-treatment of the components prior to and during installation. During the program, more than 250 determinations were made to study the factors which influence the susceptibility of carbon-moly steel to graphitize at 925 F. No single factor appears to control the rate; rather a combination of stress, time, chemical analysis, grain size, abnormality, and structure are factors which must be considered in combination. Stress, as defined by location in the system, was rated as one of the most significant factors.

The small diameter (2 in. and under) pipe and fittings which operated in the 800 to 925 F temperature range were included in the over-all sampling program of the No. 3 Boiler. The valves and fittings had high (0.05 per cent) aluminum contents and moderate to severe graphitization; the pipe was typically low in aluminum and molybdenum and was mildly graphitized. When this condition was found, it was more economical and expedient to replace the small diameter piping systems than perform remedial repair. Connections such as fittings to heavy wall pipe were particularly susceptible to graphitization because of localized stress.

The authors agree with the reviewers that each station must determine the most practical solution to its graphitization problem.

J. B. Nuchols.[12]
J. R. McGuffey.[13]

[12] Assistant Production Superintendent, Power, Union Carbide Nuclear Company, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn.

[13] Superintendent of Metallurgical Engineering Department, Union Carbide Nuclear Company, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn.

A Maintenance-Control Center

Comment by S. F. Rarig[14]

IN THIS paper[15] the author gives an excellent description of the over-all function of a maintenance-control center. This writer has been associated with the author in several plants of various sizes where the control-center concept was introduced and developed successfully. In each case definite improvement in the quality and efficiency of maintenance resulted. Machine down time was reduced, along with maintenance overtime-labor costs, and the plant-maintenance crew handled more work with less help from outside labor forces.

The causes for these improvements are numerous. Some are fairly obvious after looking at the organization chart of a control center and its basic job-control procedure. But it is just as obvious that a control center will be successful in attaining its goals only if the key personnel, "the people," successfully carry out their roles.

The operation of a control center involves labor supervisors (salaried and/or hourly), production supervisors, plant management, accounting personnel, hourly workers, procurement personnel, and members of the control center itself. Needless to say, there must be a thorough understanding of the control-center concept by all these people to obtain a smooth operation and satisfactory results.

Several steps are necessary upon introducing a control center into a plant:

1 Review the over-all concept and organization with top-plant management. Outline areas where maintenance improvements may be expected. Caution management that these gains will not result "overnight." A minimum of one year is normally required to indoctrinate personnel and develop the necessary teamwork to produce positive results. This teamwork includes that of top management in necessary departmental reorganization and in expenditures for new maintenance equipment which may be requested.

2 Conduct meetings with maintenance-supervisory personnel to outline the over-all control-center organization. Point out the responsibilities of the maintenance supervisor and the control center in planning and accomplishing jobs. Indicate the anticipated results. The maintenance supervisor will be assisted by the control center so that he will have more time for direct supervision.

3 Conduct similar meetings with production supervisors, indicating their responsibilities and anticipated gains to them through reduced machine down time and improved maintenance-cost control.

4 Review with accounting and purchasing groups the responsibilities of the control center in maintenance-cost records and material procurement. Outline proposed new methods for recording costs of labor and materials, utilizing IBM or other machine-accounting systems.

5 Familiarize engineering department heads with control-center procedures for accomplishing engineering jobs. Also, outline responsibilities of engineering in working with the control center in

[14] Maintenance-control engineer, Scott Paper Company, Everett, Wash.

[15] L. G. Stine, "A Maintenance-Control Center," MECHANICAL ENGINEERING, vol. 81, June, 1959, pp. 61–64.

solving day-to-day problems throughout the plant.

The afore-mentioned steps are an absolute necessity for creating a satisfactory basic understanding of the control-center concept. Similar meetings are necessary periodically to establish new policies, review procedures, and maintain a dynamic approach to new maintenance problems.

A control center by definition assumes many of the planning, scheduling, procuring, and stenographic responsibilities formerly held by others in the maintenance, production, and engineering groups. Sometimes these responsibilities are released only with great reluctance. Control-center personnel must prove that by assuming these responsibilities, an improved maintenance program will result.

As stated before, a one-year period is normally required to organize the control center, train personnel, and establish records which begin to measure the effectiveness of the maintenance program. During this period, continued emphasis must be placed upon defining the responsibilities of all personnel involved and in establishing procedures best suited to the individual plant.

The control-center program is designed to work in small, medium, or large plants. It can be adopted to all types of manufacture; it can stress any of the many facets of maintenance (machine shutdown, preventive maintenance, lubrication, cost control, spare parts, maintenance methods, labor incentives, and so on).

The control center enhances recognition of the maintenance function within a plant. By working with the control center, production, management, and engineering supervision become better acquainted with the maintenance role. They recognize that good maintenance of complicated machinery is a means for gaining increased production with lower unit costs. Thus the stature of the maintenance function is increased.

The control center is an excellent training area for engineers or talented personnel from the hourly ranks. Control-center personnel are in contact many times daily with supervision from all phases of the plant activity. A good insight is gained in cost accounting and procurement policy. Maintenance methods are constantly under consideration to reduce time and material costs. Reports are prepared concerning various phases of the maintenance program. Much reading is required to keep abreast of new maintenance materials and procedures. Leadership is provided for various types of meetings and discussions. All of these are of great value in developing personnel for later positions in maintenance, engineering, or production functions.

In summary, this writer is firmly convinced of the soundness of the control-center concept. This writer is equally convinced of the necessity for all key personnel to thoroughly understand this concept and their roles within it. If this is accomplished, the control-center horizons are unlimited and the plant with a maintenance-control center is most fortunate.

Authors' Closure

Mr. Rarig has been successful in the supervision and development of "maintenance control center" activities, having had experience with both East Coast and West Coast labor groups. His leadership has permitted cost reductions up to 20 per cent in some of the installations he has supervised.

As discussed by Mr. Rarig, placing the emphasis on "people" is essential in the development of a successful "control center." Because of the responsibilities for co-ordination of maintenance with production, accounting, purchasing, and many other plant groups, control center personnel must be of a high caliber and must be "salesmen" as well as have a good maintenance background. Also, the proper introduction of the control-center concept is important in making a successful installation. All plant supervision, especially top management, must be behind the principles involved to achieve a maximum benefit. Mr. Rarig has "hit the nail on the head" in discussing his practical experience in maintenance-control center installations.

Lester G. Stine.[16]

[16] Partner, Associated Industrial Consultants Trenton, N. J. Assoc. Mem. ASME.

Clothed Man

Comment by L. P. Herrington[17]

TOTAL body-heat content and skin-boundary temperature are the parameters which should be quantified as the resultants of thermal stress, compound insulation, and variable heat production under nonequilibrium conditions of human exposure. The authors[18] show that at least 12 factors must be considered in a mathematical treatment of this problem.

As a first approximation to simpler solutions, an electrical analog has been constructed with takes account of the insulation effect of several clothing assemblies appropriate to different climates of military importance. The electrical analog simulates the effect of ambient air temperature, radiation, and windspeed, acting on a constant deep body temperature through analog elements which represent resistance and capacity effects in the insulation and a variable peripheral tissue resistance determined by the type of physical activity.

A number of simplified assumptions were employed in this demonstration analog unit; however, the time course of skin-boundary temperatures in analog simulation of severe exposures was in gross agreement with empirical observations. This general agreement was clearest when the questions put to the analog were qualitative; that is, problems in which the decision was a matter of greater or lesser efficiency in such matters as reheating of exposed subjects by work as contrasted with simulated return to a warmer environment.

As a question to the authors it would be interesting to know the modifications required to extend the analog to include heat storage.

We agree that a principal value of the present circuit would be in providing pre-experimental exploration of a field problem for the purpose of clarifying the experimental design of exposure tests with human subjects.

Author's Closure

In answer to the question by Dr. Herrington, heat storage in the periphery is represented by the charge on the capacitor representing the skin. If total heat storage is required, a capacitor twice that of the periphery is added to represent storage in the core. However, when this is done, current representing metabolic heat input must be supplied from a variable source, which is independent of voltage, such as the plate of a pentode. Vasoconstriction is adjusted by a pentode tube, the grid of which is maintained at a fixed potential. The cathode is con-

[17] Director of Research, John B. Pierce Foundation, New Haven, Conn.

[18] A. H. Woodcock, H. B. Thwaites, and J. R. Breckenridge, "Clothed Man," MECHANICAL ENGINEERING, August, 1959, vol. 81, 71–73. Condensed from Paper No. 58—A-252, "An Electrical Analog for Studying Heat Transfer in Dynamic Situations."

nected to the point representing the core so that, as core potential varies, more or less current flows to the point representing the periphery.

The major problem of such an analog is in providing a mechanism to represent sweating or latent heat loss for a clothed man with provision for sweat absorbtion and/or condensation in the clothing. This seems to demand two types of electricity; one for sensible heat and one for latent heat, but unfortunately there is only one!

Alan H. Woodcock.[19]

[19] Chief, Biophysics Branch, Environmental Protection Research Division, Quartermaster Research & Engineering Command, U. S. Army, Natick, Mass.

BOOKS RECEIVED IN LIBRARY

Grundlagen der Selbsttätigen Regelung. BAND I
By W. W. Solodownikow. 1959, R. Oldenbourg, Verlag, Munich, Germany. 727 p., $7^1/_4 \times 9^1/_2$ in., bound. 65DM. This German translation from the original Russian is the first of two volumes on the fundamentals of automatic control. It deals with the theory of linearized control systems: the basic mathematics; stability analysis of systems; quality analysis and synthesis of correcting devices, and the theory of impulse regulation; problems in control systems under random circumstances. The presentation is both extensive and detailed.

High Temperature Materials
Edited by R. F. Hehemann and G. Mervin Ault. 1959, John Wiley & Sons, Inc., New York, N. Y. 544 p., $6^1/_4 \times 9^1/_4$ in., bound. $17.50. A summary of the state of knowledge as well as of recent developments in the field of materials for use at temperatures above 1500 F. The characteristics of nickel and cobalt-base alloys and cermets are summarized and the factors that control their performance are indicated. This is followed by a discussion of refractory metals, and of dispersion hardening as a means of obtaining high strength. The concluding portion of the book deals with gas-metal interactions and considers vacuum melting and its effects on properties, the effect of testing environment on properties, and oxidation resistance. The papers in this book constitute the proceedings of a conference held in Cleveland, Ohio, in 1957.

Hot Organic Coatings
By Raymond B. Seymour. 1959, Reinhold Publishing Corp., New York, N. Y. 233 p., $6^1/_4 \times 9^1/_4$ in., bound. $7.50. The constitution, applications, and properties of such hot organic materials as asphalt, coal tar pitch, petroleum waxes, and cellulose derivatives are presented. Specific information on formulations of proprietary products is included. Hot melt applications without solvent such as peel coatings, protective linings, flame spraying, and the fluidized bed process are then discussed, and a special chapter is devoted to hot applied coal tar pitch base coatings. Hot spray techniques and their advantages are also covered.

An Introduction to Advanced Dynamics
By Sidney W. McCuskey. 1959, Addison-Wesley Publishing Co., Inc., Reading, Mass. 263 p., $5^3/_4 \times 8^3/_4$ in., bound. $8.50. An intermediate text covering the concepts of classical mechanics, which is intended to prepare the reader for the modern ideas of quantum mechanics. The author discusses the fundamentals of Newtonian dynamics, Hamilton's principle and Lagrange's equations, central force motion, dynamics of a rigid body, oscillatory motion, Hamilton's equations and phase space, and the Hamilton-Jacobi equation. Emphasis has been placed on basic principles rather than on an exhaustive treatment.

Linear Programming
By Robert O. Ferguson and Lauren F. Sargent. 1958, McGraw-Hill Book Co., Inc., New York, N. Y. 342 p., $6^1/_4 \times 9^1/_4$ in., bound. $10. The origin, need for, and value of linear programming to management are discussed and the problems to which it has been applied are indicated. The technical aspects of the method are then described with principles, concepts, and procedures developed through the use of industrial problems. A concluding section provides suggestions for recognizing linear-programming problems and developing industrial applications by the use of a model. Several problems are worked out in complete detail. Two new computational methods developed by the authors are presented.

Matrix Calculus
By E. Bodewig. Second Edition. 1959, Interscience Publishers, Inc., New York, N. Y. 452 p., $6^1/_4 \times 9$ in., bound. $9.50. An enlarged and revised edition that develops further the concept of matrix calculus. The author advocates the use of rows and columns so as to avoid the use of individual elements. The four sections included discuss matrix calculus, linear equations, inversion of matrices, and eigenproblems. Among the new material included is the deflation of complex eigenvalues, the application to differential equations of the inversion of the general geodetic chain and its matricial generalization, and a new section on orthonogal matrices.

Non-Destructive Testing
By J. F. Hinsley. 1959, Macdonald & Evans, Ltd., London, England. 495 p., 6×9 in., bound. 75s. A broad survey of the field of nondestructive testing is made in this volume which discusses such aspects as the production and properties of x rays, gamma rays, radiological examination, ultrasonic vibrations and testing, surface-flaw detection with and without magnetic particles, sorting of mixed materials, and miscellaneous methods of nondestructive testing. In addition, there is a discussion of diffraction, safety precautions in radiological laboratories, and the interpretation and presentation of test results.

Nutzenergie aus Atomkernen. Band I
By Karl Rudolf Schmidt. 1959, Walter de Gruyter & Co., Berlin, Germany. 594 p., $7 \times 9^1/_2$ in., bound. 106DM. A comprehensive treatment of the practical use of nuclear energy. Beginning with a brief treatment of the fundamentals of nuclear physics, the book continues with reactor theory and the types of reactors. The materials involved are discussed and methods of operation, including moderators, refrigeration, shielding, etc. Heat-power generation, including thermodynamics, is covered, special chemical problems are dealt with, and the book closes with the preparation of fissionable fuel elements.

Operations Research
By Maurice Sasieni and others. 1959, John Wiley & Sons, Inc., New York, N. Y. 316 p., $5^3/_4 \times 8^3/_4$ in., bound. $10.25. This text begins with a brief survey of the elements of probability theory, including the concepts of probability of an event, random variable, probability distribution, and conditional probability distribution. Sampling is then discussed, and an introduction is given to the Monte Carlo method of simulated sampling. Succeeding chapters present various problem areas in operations research, specifically, inventory, replacement, waiting lines, competitive strategies, allocation, sequencing, and dynamic programming.

A Primer of Programming for Digital Computers
By Marshal H. Wrubel. 1959, McGraw-Hill Book Co., Inc., New York, N. Y. 230 p., $5^3/_4 \times 8^3/_4$ in., bound. $7.50. An introduction to electronic computing for scientists and engineers who are planning to use electronic computers as tools of research. Although, the IBM Type 650 is used in the examples given, the general techniques described are applicable to practically all stored-program computers. Topics discussed include the approach to simple problems; loops and branches; flow diagrams, subroutines, and the program library; testing programs; automatic programming; arithmetic instructions in machine language and SOAP. Practical programs are included throughout the test.

Professional Engineering Examinations. Part 1—Structural Planning and Design
By William Glendinning. Published 1959 by the author, 5123 Bell Boulevard, Bayside, N. Y. 116 p., $8^1/_2 \times 11$ in., paper. $3.35. A new edition that provides detailed solutions to past New York State engineering examinations. Topics covered include design and investigation of concrete beams, slabs, and columns; design of timber beams and joists; design, selection and determining safe load of steel columns, beams and girders; riveted joints and sections; and various other aspects of the subject.

Programming Business Computers
By Daniel D. McCracken and others. 1959, John Wiley & Sons, Inc., New York, N. Y. 510 p., $6 \times 9^1/_4$ in., bound. $10.25. Intended for the person involved in day-to-day application of electronic computers to business data processing problems, the book begins with such fundamental concepts as the central concept of the file, flow charting, and the general characteristics of electronic computers. Numerous examples are then given to explain the standard techniques of coding.

These examples are written in terms of a hypothetical computer called DATAC which is a compilation of the features of many machines. Also included are such advanced techniques as timing estimates, file organization, automatic coding, and random access storage devices. The authors conclude with a summary of the steps involved in establishing a computer application, and an examination of the accounting and auditing problems associated with electronic data processing.

Regulators and Relief Valves
By Chester S. Beard and Fred D. Marton. 1959, Instruments Publishing Co., 845 Ridge Avenue, Pittsburgh, Pa. 203 p., 5¼ × 8 in., paper. $2. A review of existing types of self-actuating regulators. Among the topics discussed are mechanically loaded and pneumatically loaded pressure regulators; pressure, temperature, and gas regulators; level regulation; safety and relief valves; automatic emergency valves; automatic shut-off valves for oil and gas transmission lines; vacuum regulation. First published as a series of articles in *Instruments and Automation*.

Report on Properties of Cast Iron at Elevated Temperatures
Published 1959 as Special Technical Publication No. 248 by the American Society for Testing Materials, Philadelphia, Pa. 90 p., 8½ × 11 in., paper. $4.25. Report on properties of six commercial low-alloy gray irons, and of one unalloyed ferritic nodular iron, evaluated at 800 F and at 1000 F by means of tensile tests, creep-rupture tests, thermal-shock tests, growth tests, and metallographic examinations. Tests showed that the alloys are promising for applications involving thermal shock at temperatures up to 800 F, but not at 1000 F. Development of alloys suitable for use to 1000 F appeared possible.

Research Techniques in Human Engineering
By Alphonso Chapanis. 1959, The Johns Hopkins Press, Baltimore, Md. 316 p., 6¼ × 9¼ in., bound. $6. Describes various methods available to the human engineer for collecting trustworthy data on men and machines and the relations between them. Methods of direct observation are considered first and characterized by observation of an actual work situation. Methods for the study of accidents and near-accidents are then discussed and followed by material on statistics and experimental methods. The book concludes with the general problems involved in experiments on people, the psychophysical methods, and the articulation test methods used in studying speech-communication systems.

Sampling Inspection Tables, Single and Double Sampling
By Harold F. Dodge and Harry G. Romig. Second Edition. 1959, John Wiley & Sons, Inc., New York, N. Y. 224 p., 8½ × 11¼ in., bound. $8. The previous edition presented a working set of sampling inspection tables for control of quality and economy of inspection within a manufacturing plant. In addition to these tables, the present edition contains a collection of "Probability-of-Acceptance" curves called Operating Characteristic curves. These curves may be used to determine how particular sampling plans chosen from the tables will operate for all possible levels of presented quality. The use of the sampling tables is discussed, and a new chapter is included which discusses the practical significance of the Operating Characteristic curves.

LIBRARY SERVICES

Engineering Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by ASME members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Servomechanisms and Regulating System Design. Vol. 1
By Harold Chestnut and Robert W. Mayer. Second Edition. 1959, John Wiley & Sons, Inc., New York, N. Y. 680 p., 6 × 9¼ in., bound. $11.75. The nature of the feedback control system problem is described and an analytical approach to servomechanism and regulator design is presented. Emphasis is placed on the complex plane, the attenuation-frequency, and root-locus methods of control system analysis of both simple and more complex systems. In conjunction with the multiple-loop systems, techniques are described for handling complicated control problems with simplified analysis methods. The use of these methods permits the designer to arrive at a workable design fairly readily. The present edition reflects recent advances within the field.

Studies in Ancient Technology. Vol. 6
By R. J. Forbes. 1958, W. S. Heinman, 400 East 72nd Street, New York 21, N. Y. 196 p., 6½ × 10 in., bound. $6.50. In this volume three aspects of ancient technology are described. Under heat and heating are included the origin and production of fire, heating the home, Roman hypocausts, industrial furnaces, and fuel. The various means for cooling and producing cold are then considered such as snow and ice, refrigeration by evaporation, and vessels for cooling drinks. The concluding section deals with light and discusses lamps, torches and tapers, and candles.

Symposium (International) on Combustion, Seventh, 1958
Published, 1959, for The Combustion Institute, by Academic Press, Inc., New York, N. Y. 959 p., 7 × 10 in., bound. $35. A comprehensive survey that begins with detonation, and in particular the transition from flame propagation to detonation. It continues with spectroscopy and the structure of flames in which modern methods of following the change of composition through a flame front are described. A substantial part of the book is then devoted to the mechanism of combustion reactions, both hydrocarbons and other substances being considered. Also investigated are ignition and limits of inflammability, combustion in practical flowing systems, special fuels, and instrumentation.

Symposium on Stability of Distillate Fuel Oils
Published 1959 as Special Technical Publication No. 244 by the American Society for Testing Materials, Philadelphia, Pa. 56 p., 6 × 9 in., paper. $2.75. Eight papers dealing with the resistance of fuel oil to breakdown or decomposition. The papers discuss stability problems, past and present, and measures to relieve them.

Symposium on Paper and Paper Products
Published 1959 as Special Technical Publication No. 241 by the American Society for Testing Materials, Philadelphia, Pa. 73 p., 6 × 9 in., bound. $2.75. Seven papers intended to acquaint the paper technologist with some of the new developments in paper technology and the methodology which has been evolved. Synthetic fiber papers, internal bonding of paper, and Clupak paper are among the topics discussed.

Technologie des Reacteurs Nucleaires Tome 1—Materiaux
By Paul Ageron and others. 1959, Editions Eyrolles, Paris, France. 567 p., 6½ × 9½ in., bound. 6900 fr. An introduction to the fundamental concepts of nuclear technology. The effects of radiation on various materials are analyzed and classified. This is followed by a discussion of the behavior of reactor materials, their mechanical properties and radiation damage, as well as the modification of physical properties or the formation of new substances. Nuclear fuels and nonfissionable materials provide the subject matter for seven chapters, while recent developments in uranium, heavy water, beryllium, and cermets are described.

The Theory of Elementary Particles
By J. Hamilton. 1959, Oxford University Press, New York, N. Y. 482 p., 6 × 9 in., bound. $12. An account of the basic mathematical methods used in investigating elementary particles and in explaining their observed interactions. The techniques dealt with fall into two categories: symmetry properties with their related selection rules, and methods for calculating S-matrix elements. Topics discussed include classical fields, quantization of boson fields, Dirac's wave equation, quantization of fermion fields and the interaction of fields, the S-matrix and renormalization, Heisenberg operators and pionnucleon scattering, selection rules, polarization analysis, and the foundations of field quantization.

Tiefbohrtechnik
By Gottfried Prikel. 1959, Springer-Verlag, Vienna, Austria. 414 p., 6¾ × 9¾ in., bound. $15.70. Deep drilling techniques are described in this companion volume to a 1957 book on drilling equipment. It covers stresses, bending and breaking points of drill rods, tool joints and their stresses, drilling muds, directional drilling, the measurement of drill hole deflections, cementing of sides and casings, tool recovery, core-drilling, etc. Jet perforation and other special methods are briefly considered.

Water Facts for the Nation's Future
By Walter B. Langbein and William G. Hoyt. 1959, The Ronald Press Co., New York, N. Y. 298 p., 5¾ × 9 in., bound. $5. The first part of this volume describes and comments on current government programs for gathering hydrologic and hydroclimatic data, as well as data on water use and development. The present mapping program is discussed, and a chapter is devoted to the question of design of an adequate national hydrologic network. Part two discusses how well all this information now being gathered is being applied to meet water control and utilization problems. Phases of water management treated are irrigation, floodcontrol, streamflow forecasting, and waste-water disposal. It is shown how inadequate data or poor use of available information has resulted in certain water problems.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

1960 Nuclear Congress Program Announced

A PROGRAM to develop the theme, "What Will the Future Development of Nuclear Energy Demand From Engineers?" is fast reaching completion. The 1960 Nuclear Congress, to be held in the New York Coliseum, April 4–7, is designed to delve deep into this subject.

All technical sessions will be held in the N. Y. Coliseum, the same building in which the International Atomic Exposition is being held. An All Congress banquet is being planned for Wednesday evening, April 6, in the Grand Ballroom of the Statler Hilton Hotel. The Statler Hilton is the headquarters hotel for the Congress.

The Congress, a gathering of representatives from all areas of the nuclear field, is sponsored by 28 leading engineering, scientific, management, and technical organizations, of which The American Society of Mechanical Engineers is one. The Engineers Joint Council will co-ordinate the programs of the participating societies.

The meetings which constitute the Congress include: The Sixth Nuclear Engineering and Science Conference, the Eighth NICB Atomic Energy in Industry Conference, and the Sixth International Atomic Exposition. The Exposition, which was established in 1954, will include at least 130 exhibits of the manifold products and services available for the peaceful use of atomic energy. The Congress sessions are expected to draw the largest audience of engineers and related specialists—as well as the largest representation of industrial and scientific exhibitors—ever to attend an event of this kind.

All Congress Session Mon. April 4 9:00 a.m.

What Will Future Development of Nuclear Energy Demand From Engineers?

Outer Space Exploration and the Nuclear Engineer, by *John Simpson*, Westinghouse Elec. Corp., Pittsburgh, Pa.

The Problem of Fuel Utilization in Future Atomic Power Plants, by *Walter Zinn*, Combustion Engineering, Windsor, Conn.

Engineering Requirements for the Future, by *W. Kenneth Davis*, Bechtel Corp., San Francisco, Calif.

Environment Sessions

Session 1 Mon. April 4 2:00 p.m.

Plant Construction and Site Selection

Results of 1959 Nuclear Power Containment Test, by *A. F. Kolflat*, Sargent & Lundy, Chicago, Ill.

Review of Shippingport Operations—Site Factors, by *J. E. Gray*, Duquesne Light Co., Pittsburgh, Pa.

Progress Report on *N.S. Savannah*, by *P. P. Eddy* and *K. W. Hess*, Nuclear Projects Office, Washington, D. C.

Civil-Engineering Aspects of Nuclear Power Plants, by *R. W. Kupp* and *J. C. Tourek*, Vitro Engineering Co., New York, N. Y.

Session 2 Tues. April 5 9:00 a.m.

State and Federal Regulations Protecting Public Health

Local Problems in Regulation, by *Hanson Blatz*, New York City Health Dept.

Status of Regulation on the State Level, by *Oliver Townsend*, N. Y. State Office of Atomic Development, Albany, N. Y.

Status of Regulation on Federal Level—Responsibilities of the U. S. Public Health, by *F. J. Weber*, U. S. Dept. of Health, Education and Welfare, Washington, D. C.

International Problems in Radiation, by *A. I. Galagan*, Office of IAEA, United Nations, N. Y.

Session 3 Tues. April 5 2:00 p.m.

Water Supply and Waste Disposal

Environmental Radioactivity in Large Area Surrounding Nuclear Electric Plant, by *J. V. Nehemias*, Univ. of Michigan, Ann Arbor, Mich.

Strontium 90 in Surface Waters, by *C. P. Straub, L. R. Setter*, and *P. F. Hallbach*, Robert A. Taft Engineering Center, Cincinnati, Ohio

Use of Tritium as a Tracer in Evaluating Waste Discharges, by *W. J. Kaufman* and *R. M. Hours*, Univ. of California, Berkeley

Hanford Reactor Effluent Contribution to Environmental Radiation Dose, by *R. L. Junkins*, Gen. Elec. Co., Richland, Wash.

Materials and Components Sessions

Session 1 Mon. April 4 2:00 p.m.

Metal Ceramic, Organic Materials

Effect of Irradiation on Tensile Properties of High-Temperature Steel and Nonferrous Alloys, by *Sam Barts*, Phillips Petroleum Co.

Experience in Use of Organic Coolant in Nuclear Reactors, by *G. O. Haroldsen, R. W. Burkhardt, W. N. Bley*, and *S. C. Spencer*, Atomics International, Canoga Park, Calif.

Problems in Contamination of Water-Cooled Reactors Using Stainless-Steel Components, by *Dennis Foley*, Alco, Inc., Schenectady, N. Y.

U. S. Bureau of Mines Research on the Fused Salt Electrorefining of Beryllium, by *K. H. Baker, Jr.*, U. S. Bureau of Mines, Washington, D. C.

Preparation of Nuclear-Grade Thorium by Sodium Reduction Method, by *F. E. Block* and *P. C. Good*, U. S. Bureau of Mines, Washington D. C.

Session 2 Tues. April 5 9:00 a.m.

Fuel Technology

Ignition and Detonation of Uranium in Boron Trifluoride Solutions, by *R. Johnson, F. Horn*, and *G. Strickland*, Brookhaven Nat. Lab., Upton, N. Y.

Uranium-Thorium Reprocessing; Cost Outlook for Commercial Operation, by *R. J. Klotzbach*, Union Carbide Nuclear Co., New York, N. Y.

Low Impurity Core Material, by *G. Pancer* and *J. L. Zegger*, Alco Products, Schenectady, N. Y.

Status of Plutonium Recycle, by *R. E. Dunn*, Gen. Elec. Co., Richland, Wash.

Reactor Sessions

Session 1 Mon. April 4 2:00 p.m.

U. S. Power Reactors Program

The Army Nuclear Power Program, by *Col. D. G. Williams*, Chief, Army Nuclear Power Program

BUDOCKS Role in the Development of Nuclear Power for the Navy's Shore Establishments, by *Commander W. J. Christensen*, CEC, U. S. Navy

Reactor Development in the Next Ten Years, by *Frank Pitman*, AEC, Washington, D. C. (Oral presentation only)

Sites for Nuclear Power Plants for Large Spanish Utility, by *Jaime Mac Veigh*, Tecnatom, Vallehermos, Madrid, Spain

Session 2 Tues. April 5 9:00 a.m.

Research Reactors and Radiation Facilities

Operation and Experimental Use of the Battelle Research Reactor, by *A. M. Plummer, A. N. Anno*, and *J. W. Chastain, Jr.*, Battelle Memorial Inst., Columbus, Ohio

Operating Experience With In-Pile Loops at ORNL, by *J. A. Cox*, ORNL, Oak Ridge, Tenn.

Construction and Operation of the McMaster Nuclear Reactor, by *W. H. Fleming*, McMaster Univ., Hamilton, Ont.

The Design of a Hot Laboratory for Metallurgical Research in Germany, by *W. Stephan*, GFKF Institute Fur Reaktorwerkstoffe, Aachen, Muffeterweg, Germany

Session 3 Tues. April 5 2:00 p.m.

Progress in Reactor Instrumentation

Application of Control and Instrumentation, by *Walter Lapinski*, Argonne Nat. Lab.

Application and Effect of Control and Instrumentation, by *C. F. Obermesser*, Westinghouse Elec. Corp.

C & I Equipment—In-Core, by *H. M. Ogle, J. Forster, H. H. Henson*, and *J. H. Keeler*, Gen. Elec. Co., San José, Calif.

C & I Equipment—External, by *E. P. Epler*, Oak Ridge Nat. Lab.

Significance and Need of C & I, by *H. E. Vann*, and *F. C. Legler*, Atomic Energy Commission, Washington, D. C.

Session 4 Wed. April 6 9:00 p.m.

Advanced Reactors and Fuel Cycles

Advanced Water Cooled Reactor, by *W. E. Shoupp* and *J. H. Wright*, Westinghouse Elec. Corp., Pittsburgh, Pa.

Army Gas Cooled Reactor Systems Program, by *M. A. Rosen* and *Capt. G. A. Bicher*, AEC, Washington, D. C.

High-Temperature Gas-Cooled Graphite-Moderated Reactor (HTGR), by *David Rose*, Gen. Dynamics Corp., San Diego, Calif.

Nuclear Superheater Designs and Fuel Cycles, by *E. L. Zebroski, K. M. Horst*, and *P. G. Aline*, Gen. Elec. Co., San José, Calif.

Session 5 Wed. April 6 2:00 p.m.

Reactor Design Engineering

Determination of Pressure in a Two-Phase Water System, by *W. H. Comtois*, Combustion Engineering, Inc., Windsor, Conn.

Hydraulic Instability of Reactor Parallel Plate Fuel Assemblies, by *E. B. Johansson*, KAPL, Gen. Elec. Co., Schenectady, N. Y.

Natural Convection Flow in Liquid-Metal Mobile-Fuel Nuclear Reactors, by *F. G. Hammitt* and *E. M. Brower*, Univ. of Michigan, Ann Arbor, Mich.

A Method for the Economic Comparison of the TH-U235 Fuel Cycle Vs. the U238-U235 Fuel Cycle With Application to the MCCR, by *R. T. Sahnstrom*, General Atomics

Aircraft Sessions

Session 1 Thurs. April 7 9:30 a.m.

Components for Nuclear Propelled Aircraft and Space Vehicles

Nuclear Propulsion for Lifting (Large) Space-Stations Into Orbit, by *R. A. Mayer*, Norair Div. of Northrop Corp., Hawthorne, Calif.

Nuclear Ramjet Developments, by *T. C. Markel*, Univ. of California, Radiation Lab., Livermore, Calif.

Some Practical Methods for Fabricating Shields for Nuclear Powered Aircraft, by *W. Q. Hullings* and *J. L. McDaniel*, of Covair, Fort Worth, Texas

Session 2 Thurs. April 7 2:00 p.m.

Nuclear-Powered Air Vehicles

The Nuclear Propelled Airship, by *Leo Jurich*, Goodyear Aircraft Corp., Akron, Ohio

Potential of Nuclear Powered Aircraft for Commercial Cargo, by *J. F. Brady, Jr.*, of Covair, San Diego, Calif.

Three Approaches to Achieving Reliability for Nuclear Powered Navy Aircraft, by *L. W. Credit*, Nuclear Div., The Martin Co., Baltimore, Md.

Nuclear Standards

Senior representatives of each of four specification and code-writing organizations interested in nuclear standards will present discussions of the interests, aims, and methods of their organizations in furthering the development of satisfactory standards in the nuclear industry. The speakers and their organizations are:

N. L. Mochel, Westinghouse Elec. Corp., Lester Station, Philadelphia, Pa., for the American Society for Testing Materials

C. R. McCullough, Atomic Energy Commission, Washington, D. C., and chairman of the American Nuclear Society Standards Committee, ANS

Eugene Bailey, Commonwealth Edison Co., Chicago, Ill., for ASME Special Committee on Nuclear Power of the Boiler and Pressure Vessel Committee

J. A. Klapper, Ebasco Service Inc., New York, N. Y., for American Standards Association

D. A. Rogers, Allied Chemical & Dye, Morristown, N. J., Committee on Nuclear Power of ASME Boiler and Pressure Vessel Committee

Isotope Application Session

Session Wed. April 6 9:00 a.m.

Industrial Radioisotope Applications Development Sponsored by AEC, by *P. G. Aebersold*, U. S. AEC, Washington, D. C.

Isotopes in Petroleum Production, by *Milton Williams*, Humble Oil & Refining Co., Houston, Texas

Field Techniques and Instrumention for Radioactive Gas Tracers, by *F. E. Armstrong*, U. S. Bureau of Mines, Washington, D. C.

Isotopic Power, by *J. G. Morse*, The Martin Co., Baltimore, Md.

Radiation Processing Session

Session Wed. April 6 2:00 p.m.

Progress and Problems in Radiation Processing of Foods, by *Walter Urbain*, Swift & Co., Chicago, Ill.

Commercial Technology and Economics in Radiation Processing of Biological Materials, by *H. F. Kraybill*, Curtiss-Wright Corp., Princeton, N. J.

Radiation Technology for Nonbiological Materials, by *A. J. Restaino*, Atlas Powder Co., Plainsboro, N. J.

Current Aspect of the Wholesomeness of Irradiated Food, by *Merrill Read*, Fitzsimmons General Army Hospital, Denver, Colo.

Institute of Defense Analyses Meets With EJC

Dr. Kenneth S. Colmen and two technical officers of the Institute for Defense Analyses were guests at a luncheon held by the Engineers Joint Council on Friday, Dec. 18, 1959, at the Engineers' Club in New York City. Purpose: To inform the EJC's Executive Committee on the personnel needs of the Institute.

The Institute for Defense Analyses is a nonprofit corporate entity of U. S. universities responsible for fundamental evaluation of our military weapons systems and defense strategy for the Department of Defense.

As a primary link in the DOD structure, IDA plays a vital role in our national security. Among its continuing problems is that of providing top caliber engineering and scientific personnel to evaluate, plan, and report on our increasingly complex technological defense weaponry.

Officers of IDA had requested the opportunity of explaining to EJC and its societies (of which ASME is one) the functions and manpower needs of their organization. Their objective was to secure a better rapport with the engineering profession and to enlist the societies' support in locating qualified engineers to serve tours of duty in this essential defense activity.

Dr. Colmen explained that the Department of Defense in 1955, recognizing a need to sharpen its scientific discernment for weapons evaluation, approached the academic community for assistance. In response to a specific request from the Secretary of Defense, five universities joined, in 1956, in the creation of IDA, a professional consortium designed to render technical assistance to the national security. The five universities are: California Institute of Technology, Case Institute, M.I.T., Stanford, and Tulane. The largest of IDA's several activities continues to be the technical support of the Weapons System Evaluation Group of the Department of Defense. Through WSEG, IDA accepts a heavy work load from the Joint Chiefs and from the Director of Defense Research and Engineering.

Calling for Engineers. The need is for engineers capable of evaluating weapons systems independently, cutting across industrial lines. There must be no industrial bias. Where industry has loaned men, these men have avoided company bias rigidly. But more independent engineers are needed.

Engineers Joint Council will assist in finding men to staff the key jobs. The IDA organization is not under Civil Service. The work carries with it the excitement and satisfaction of contributing to decisions of awesome importance in the nations security. The task will never be completed so long as that security is threatened.

The work is all Top Secret, and everybody must be cleared for security. Wanted are men concerned with advanced research in missiles, or any other defense development that overlaps the services. IDA provides inputs on which major strategy decisions are based.

I. MECH. E. MEETINGS

Computer in Production

An informal discussion on the Computer in Production will be sponsored on March 21 and 22, 1960, by The Institution of Mechanical Engineers. Purpose of the meeting is to introduce mechanical engineers and managers to the latest techniques involving the application of computers in production; and to provide a forum for managers, engineers, and users to present their views to manufacturers of computers.

Visits are planned to computer centers and installations where computers are being used on production problems. Those who wish to attend, apply to: The Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London S.W. 1, England. ▶ *Note:* The foregoing calendar of The Institution of Mechanical Engineers (Great Britain) meetings is published as a service to members of ASME.

AAAS Section M (Engineering) in Operation SCUDS Reviews National and International Aspects of Systems of Units

By Carl F. Kayan, Fellow ASME

At the 126th annual meeting of the American Association for the Advancement of Science, held in Chicago, Ill., Dec. 26–30, 1959, Section M (Engineering) again made a strong appeal for consideration of national and international aspects of systems of units. In a four-part symposium, Section M, on December 28 and 29, presented papers by 24 United States and foreign authorities.

Operation SCUDS—Simplification, Clarification, Unification, Decimalization, and Standardization—was the special theme of the Section M Meeting.

Object: To focus attention on the contributions to Unit confusion of our common-fractions (called "vulgar fractions" abroad), particularly as applied to mixed subunits of our measurement systems of length, weight, and the like. Thus, while the Chicago meeting continued the pattern set at the 1958 meeting in Washington, D. C., it now emphasized the contributing aspects of our "national arithmetic" and the importance of decimalization.

The American Society of Mechanical Engineers was well represented at this symposium. In addition to Secretary-Emeritus C. E. Davies, vice-president of AAAS and chairman of Section M, and Prof. Carl F. Kayan of the Columbia University Mechanical Engineering Department, who served as chairman of the Program Committee, ASME President Walker L. Cisler was an active keynote participant.

The symposium program was presented in four parts which spelled out the theme as follows: The Confusion of Chaos in Units; Public Education versus the Consumer Public; Problems of Design, Manufacture, and Commerce; and The Look to the Future.

Among those participating in the first session, in addition to President Cisler, were Dr. John J. Theobald, Superintendent of Schools in New York, on "International Challenge to American Education and Its Relationship to the Unit System," and Adm. George F. Hussey, Jr., Managing Director of the American Standards Association, "Should American Industry Convert to the Metric System?" President Cisler's paper was entitled "International Viewpoint of an American Engineer on Units."

President Cisler opened the four-session conference with a spirited reminder of the urgency for the solution of the problem of the diverse conventions for measurements as used in the world today. He pointed out that much progress has been made in the world in the fields of economic and political understanding, but that much remained yet to be accomplished as concerns units and the confusing situations that are involved. "Although the laws of nature that we study and exploit for human betterment are the same for every nation, we speak in different languages; and, more particularly, we are at variance in our choice of technical terms and units of measurement. We are gathered here, today, to focus upon and to scrutinize this problem of removing barriers to communication in the expression of measurements."

Decimalization, it was brought out by the Program Chairman, could ultimately be the first step toward adoption of a metric system; could, meanwhile, make our own every-day life a whole lot simpler; and, perhaps, make our own units less horrendous in the minds of metric-minded people abroad.

De-emphasized study of tedious common-fraction arithmetic with its dubious ultimate commensurate use, and the earlier teaching of decimals, further, might well go a long way toward making students less prejudiced against "mathematics" and science, and might well serve as a fruitful educational elixir for students in this competitive Space Age.

The teaching of decimals in the United States, he added, right from the early grades on would seem to be a "natural," since we have a decimalized currency and penny-dime-dollar practical philosophy so richly entrenched in children of even preschool age. The thought was expressed that we might well think popularly of decimal fractions of the inch, decimal stock-market quotations, and decimal weight fractions inspired by a "bounce-the-ounce" campaign.

Thus consumer packages picked off a supermarket shelf might readily be compared pricewise, if marked decimally. Many of our odd units, often so tediously learned and rarely used, could be relegated to an encyclopedic museum. And a first step in the ultimate resolution of the confusion of our American units would be taken.

With such a simplification, backed by education of our people at the "grass-roots" level—via decimalization—our state of knowledge in the realm of "national arithmetic" would be greatly enhanced. Popular understanding leading to a future adoption of a metric system would then be more realistic. Meanwhile, of course, international technologists might well work within the metric framework.

At Chicago, the philosophy and use of American versus metric units in the various fields of industry, technology, commerce, and public consumption were widely explored. And again, as at the Washington meeting a year ago, a representative of the British Association for the Advancement of Science, T. P. Thomas, reported on the status and attitude concerning metric changeover and decimalized coinage for the United Kingdom.

The 28 papers of the 1958 Symposium now have been issued as a Symposium volume by the American Association for the Advancement of Science and provide much for contemplative thought.

PEOPLE

Honors and Awards. Haraden Pratt, secretary of IRE and former telecommunications adviser to the President, has been named the recipient of the IRE 1960 Founders Award. Presentation will take place at the 1960 IRE International Convention banquet at the Waldorf-Astoria Hotel, New York, N. Y., on March 23. Others to be honored are: Harry Nyquist, former Bell Telephone Laboratories scientist and consultant, the 1960 Medal of Honor; J. A. Rajchman, RCA Laboratories, Princeton, N. J., the 1960 Morris Liebmann Memorial Prize Award; J. W. Gewartowski, Bell Telephone Laboratories, Murray Hill, N. J., the 1960 Browder J. Thompson Memorial Prize Award; K. A. Norton, National Bureau of Standards, Boulder, Colo., the 1960 Harry Diamond Memorial Award; and E. J. Nalos, General Electric Company, Palo Alto, Calif., the 1960 W. R. G. Baker Award.

William Francis Gibbs, Hon. Mem. ASME, naval architect and marine engineer who has been widely recognized

as the country's foremost designer of large ships, has been awarded the Michael I. Pupin Medal for outstanding "service to the nation."

James F. Fairman, senior vice-president, Consolidated Edison Company, New York, has been awarded the 1959 Edison Medal by the American Institute of Electrical Engineers. Presentation was made during the winter general meeting of AIEE, January 31–February 5, in New York City.

Paul G. Shewmon, assistant professor of metallurgy, Carnegie Institute of Technology, Pittsburgh, Pa., is the recipient of two major engineering awards, one sponsored by five societies and the other by the AIME. The Alfred Noble Prize, a joint honor of AIME, ASCE, ASME, AIEE, and the Western Society of Engineers, and the Rossiter W. Raymond Memorial Award, given by AIME, will be presented for the same technical paper. The paper, entitled "The Redistribution of a Second Phase During Annealing in a Temperature Gradient," was published in October, 1958, in the *Transactions of The Metallurgical Society of AIME*.

Augustus B. Kinzel, vice-president in charge of research, Union Carbide Corporation, and president-elect of Engineers Joint Council, has been named recipient of the AIME James Douglas Gold Medal. Dr. Kinzel was selected "for outstanding contributions and inspiring leadership in the field of electrolytic and electrothermic winning of nonferrous metals and for his notable administrative ability."

New Appointments. Francis L. Jackson, Assoc. Mem. ASME, has been named assistant director of The Franklin Institute Laboratories. In the newly created post, Mr. Jackson will assist Dr. Nicol H. Smith, laboratories director, and continue his present duties as technical director of nuclear and mechanical-engineering activities.

Herbert Hoover, Hon. Mem. ASME, has been added to the advisory council of the Society for the History of Technology. The society is a pioneering organization aimed at bringing together scholars from many disciplines interested in studying the impact of technology on society. The society, which was founded at Case Institute of Technology in 1958, has also announced plans for the publication of a new journal, *Technology and Culture*. Among the other members of the advisory council are United States Senator Ralph E. Flanders, past-president and Hon. Mem. ASME; Mervin J. Kelley, retired chairman of the Bell Telephone Laboratory; Lennox R. Lohr, director of the Museum of Science and Industry in Chicago; and Lewis Mumford, the noted writer. David B. Steinman, builder of the Mackinac Bridge, is president of the society.

William Lane DeBaufre, Fellow ASME, third from left, was recently honored by the Nebraska Section ASME on the occasion of his receipt of the ASME Fifty-Year Pin. Professor DeBaufre is a retired University of Nebraska professor widely known as an authority on the separation of gaseous mixtures. Shown with Professor DeBaufre are, left to right: A. A. Luebs, Mem. ASME; M. E. Jansen, Assoc. Mem. ASME; and W. H. Barnard, chairman of the mechanical engineering department, University of Nebraska.

New Officers. H. W. Ritchey, vice-president and technical director, Rocket Division, Thiokol Chemical Corporation, was elected vice-president of the American Rocket Society at the group's 14th annual meeting in Washington, D. C. Dr. Ritchey is one of the foremost proponents of solid-propellant rocketry.

Augustus B. Kinzel has recently been appointed chairman of the Division of Engineering and Industrial Research for the National Academy of Sciences-National Research Council. Dr. Kinzel succeeds the late Vice Admiral Edward Lull Cochrane, USN (Ret), Hon. Mem. ASME.

Campus Data. Thomas R. Kane, Mem. ASME, associate professor of mechanical engineering, was among the recipients of faculty awards at the University of Pennsylvania.

Edward Saibel, Mem. ASME, professor of mechanics at Rensselaer Polytechnic Institute, Troy, N. Y., has embarked on a month's tour of India as a guest of the Indian Government. Dr. Saibel, widely known for his work in hydrodynamic theory of lubrication, theory of vibrations, mechanical properties of materials, and stress analysis, participated in the Indian Science Congress at Bombay and addressed a number of other technical groups during visits to Calcutta, Kharagpur, and Bangalore.

COMING MEETINGS

Engineering Ceramics

A conference on the mechanical properties of engineering ceramics will be held at North Carolina State College, March 9–11, 1960. Sponsored by the college's School of Engineering and the Office of Ordnance Research, United States Army, the three-day conference will be of interest to research scientists and materials engineers concerned with ceramics and cermets, currently of much interest for many high-temperature, high-stress engineering applications.

For information write: W. W. Kriegel or Hayne Palmour, conference co-chairmen, School of Engineering, North Carolina State College, Raleigh, N. C.

Heat Transfer Symposium

A Heat Transfer Symposium, sponsored annually by the mechanical-engineering department of the University of Florida, will this year be held on March 7 and 8, 1960. Several sessions, to be held in the Engineering and Industries Building of the Gainesville, Fla., school, will include basic principles, temperature and its measurements, heat exchangers, graphical methods, the hydraulic analog, and other selected topics.

For additional information, write: Prof. J. C. Reed, Head, Mechanical Engineering Department, University of Florida, Gainesville, Fla.

Operation Homestretch

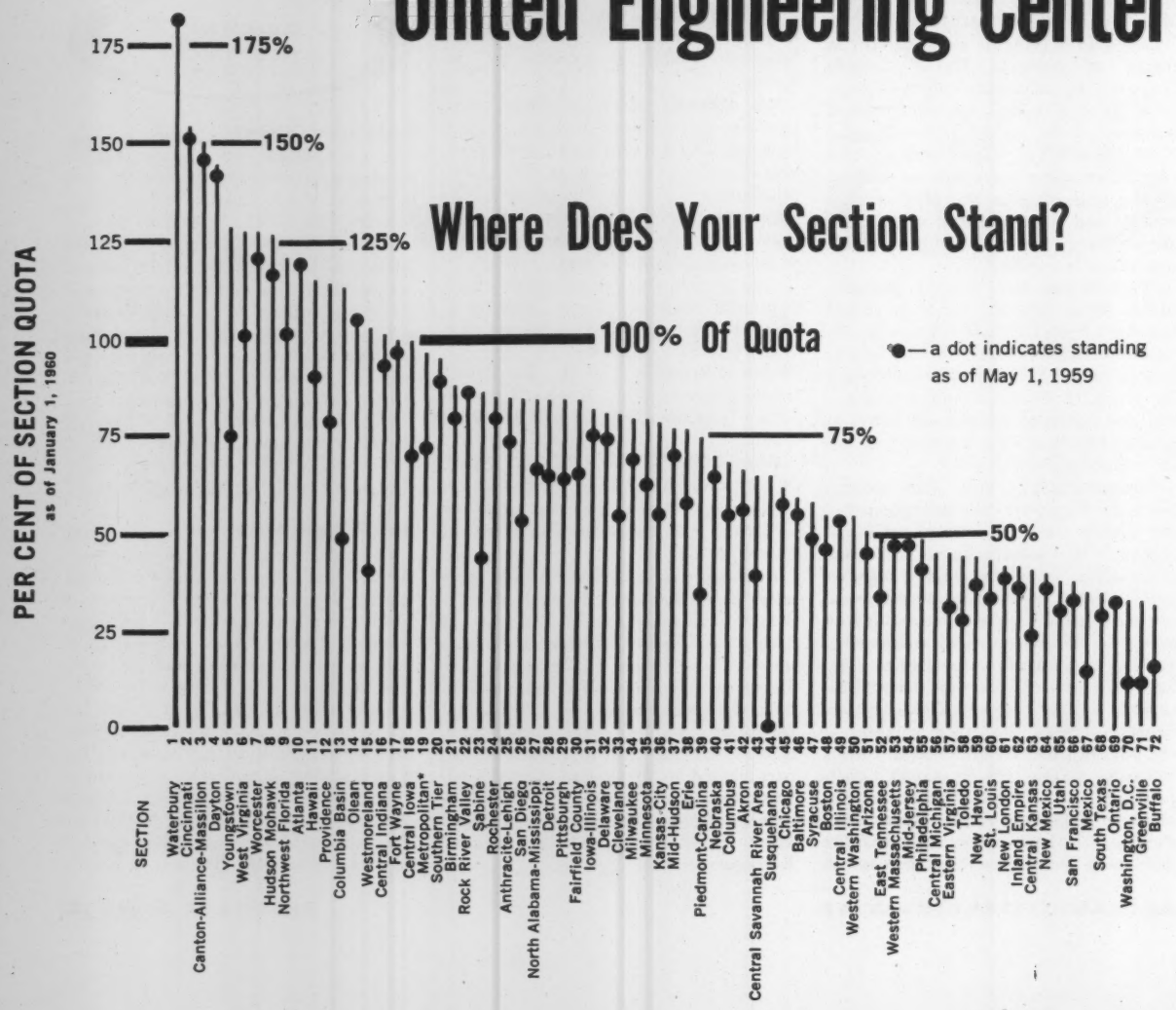
Pay to the order of . . . United Engineering Trustees, Inc. . . . **Five Thousand and 00/100 Dollars ($5000).** That's the amount on the check being held by ASME President Walker Cisler, **right.** It was presented to the United Engineering Center Building Fund Campaign, on behalf of the ASME Oil and Gas Power Division by E. J. Kates, OGP treasurer, **center.** John Gibb of the OGP Executive Committee looks on.

"Operation Homestretch," the final lap of the ASME Member Gifts Campaign, is already under way. At a special Executive Committee meeting of the ASME Council on Dec. 1, 1959, the decision was made to reorganize the existing Member Gifts Committee under the new chairmanship of 1960 President Walker L. Cisler. At the same time, the Committee expressed "sincere appreciation to Past-President William F. Ryan, Chairman F. L. Bradley, Vice-Chairman, and those Vice-Presidents who served with them as members of the ASME Member Gifts Committee."

The new committee headed by Walker Cisler will consist of Vice-Presidents or their designated representatives. It will pursue twin programs. The first will aim at encouraging each of the Sections that has not yet achieved its quota to speed its work. The second is designed to further encourage "Special Gifts"

United Engineering Center

Where Does Your Section Stand?



from individuals and selected industrial concerns around the country. A spring target date has been set.

In commenting on the future of Operation Homestretch, President Cisler said:

"We face this year an especially urgent responsibility. In addition to our normal duties as members of ASME, we *must* complete the member gifts fund-raising campaign for the new Society headquarters now under construction.

"When I was asked to assume the chairmanship of this fund-raising endeavor in December, I was happy to learn that, under the chairmanship of Past-President Ryan, ASME had already completed some 75 per cent of its goal. Mr. Ryan has carried this burden for two years and deserves our warm thanks. Since then, another 5 per cent has been achieved.

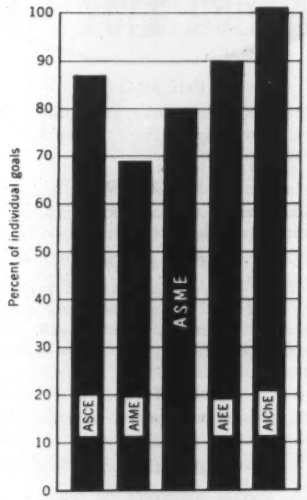
"This does not mean, however, that we can permit ourselves to relax, for the task must be completed and completed soon. I hope that, no later than the Summer Annual Meeting in June, I will be able to report that every Section has oversubscribed its quota.

"As you can realize from the accompanying table, many Sections still have a long way to go to reach 100 per cent. Although some Sections have surpassed or are nearing their quotas, others, regrettably, are lagging and some are behind badly. It is alarming that over a third of our Sections, after two years, have achieved less than half of their quotas and a dozen less than 25 per cent. I am sure this situation gives us all deep concern.

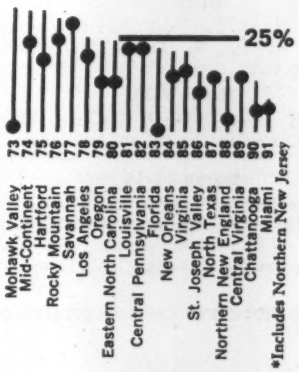
"The United Engineering Trustees and its Real Estate Committee have overcome many obstacles in bringing the building to its present state of progress with active construction under way. They have striven against serious odds to provide a building of which the engineering profession will be proud and which it can afford. In the light of the extraordinary caliber of leadership displayed by those who are taking the brunt of the responsibility for providing the new Center, the disappointing performance of some ASME Sections is particularly distressing.

"Especially, I call on the members and officers of these Sections to revitalize their drives and to work toward their objective not only vigorously but *speedily*. Each passing day our task becomes more difficult. With prompt action, however, there is no reason why we cannot complete this vital task at least as soon—and at least as well—as our sister societies. I have every confidence that our concern will stimulate us to move ahead and that we will assume a position of leadership consistent with the traditions of our society."

How Is ASME Doing?



United Engineering Center Building Fund Member-Gifts Campaign status as of Jan. 1, 1960



The signal for ASME's "Operation Homestretch" was set off when this giant power shovel bit out a mouthful of dirt to make way for the 18-story stainless-steel curtain-walled United Engineering Center. Its location: 845 United Nations Plaza in New York City. The new Center—to be constructed at a cost of more than $12 million—will stand as a symbol of the vigor of the engineering profession to serve our country.

Fourth Engineering Technician Survey of Enrollments and Graduates

A REPORT summarizing the results of the fourth survey of engineering technician enrollments and graduates has been published in the *Journal of Engineering Education*, December, 1959.

The report, prepared by the Manpower Studies, Technical Institute Division, American Society for Engineering Education, D. C. Metz, chairman, was undertaken after a lapse of three years.

(Results of the Twelfth Annual Survey prepared by Leo F. Smith were reported in MECHANICAL ENGINEERING, November, 1956, pp. 1076–1077.)

Usable data for the fourth survey were collected from 207 schools for the years 1957–1958 and 1958–1959. Thirty five of these schools have engineering technician curriculums accredited by Engineers' Council for Professional Development.

Full-time enrollments in 1958–1959 increased ten per cent to 43,902 with two thirds of the schools reporting increases over 1957–1958. ECPD-accredited curriculums increased six per cent with 60 per cent of the institutions reporting increased enrollments. The 207 schools reported total full-time and part-time engineering technician enrollments of 78,539.

Full-time graduates were estimated to increase 16 per cent to 12,899 in 1958–1959 with the total full-time and part-time to be 15,627. Seventy per cent of the 176 institutions reporting full-time graduates expected an increase over 1957–1958. It is believed generally that graduates who have attended school on a part-time basis materially do not affect the available engineering technician supply since most are fully employed while attending school. They also represent less than 20 per cent of the total while part-time enrollments are nearly 45 per cent of the total.

For this survey 556 schools were contacted with 388 replies being received. Forty-eight could not be used for one reason or another. One hundred and thirty-three institutions reported that no engineering technician curriculums were offered. Replies indicated information on part-time students frequently was not available readily. Data on part-time graduates most often were omitted.

Of some significance is the wide range in enrollments of the various schools. Only eight reported enrollments of more than 1000 full-time students while more than one half reported less than 100. The peak was 1961 with one institution reporting only one full-time enrollment. The number of graduates from full-time attendance showed a similar wide range from 0 graduates to 900. Seven schools anticipated more than 300 graduates each, while 85 per cent expected less than 100.

It appears that more and more schools are offering programs for engineering technicians but with only slight effect on the trained technical manpower supply. Since 1955–1956 an increase of 40 per cent in number of schools reporting shows slightly over 30 per cent increase in enrollment and only a two per cent increase in number of graduates.

INDUSTRIAL FILMS

Control Valves

"MUSCLES of Control" is a 16-mm, 25-min film made available to industry by Fisher Governor Company, Marshalltown, Iowa. The sound-and-color film depicts the design and functionings of automatic control valves, problems of corrosion and erosion, considerations in choosing valve styles and characteristics. Animated sequences illustrate control-valve functions in process systems and various phenomena such as cavitation and turbulence. Available from: Fisher Governor Company or their nearest representative.

Fire Protection

"FIRE Barriers by Overly" is an eight-minute sound-and-color film showing Underwriters' Laboratories fire-testing and applications of a new metal-and-glass fire and smoke screen. The film illustrates how the new screens can be placed in corridors of hospitals, schools, and other buildings to provide areas of refuge within a building. Available from: Overly Manufacturing Company, Greensburg, Pa.

Technical Film Catalog

SPECIALIZED motion pictures about new products, advanced industrial processes, and cost-saving techniques are listed in a new revised edition of the "Business and Professional Film Catalog" just published by Modern Talking Picture Service. The films are available on free loan to technical groups, universities, business and professional audiences, and other groups with specialized interests. Copies of the illustrated catalog are being distributed free. Available from: Modern Talking Picture Service, Inc., 3 East 54th Street, New York 22, N. Y.

Metal Castings

"CAST Metals and You," depicts the vital role of metal castings in the everyday lives of modern man. The film has been released by the Education Division of the American Foundrymen's Society. In color and sound, the film dramatizes the importance of an age-old industry to every conceivable type of product known today.

The film is available for showings to educational institutions and civic groups at no cost except transport charges, and to others at a rental fee of $10 and shipping costs. Available from: American Foundrymen's Society, Golf and Wolf Roads, Des Plaines, Ill.

MEETINGS OF OTHER SOCIETIES

Feb. 10–11

American Nuclear Society, gas-cooled nuclear-reactors symposium, The Franklin Institute, Philadelphia, Pa.

Feb. 14–19

AIME, annual meeting, Statler Hilton and Sheraton-Atlantic Hotels, New York, N. Y.

Feb. 16–18

Southwest Research Inititute and Society of Nondestructive Testing, symposium on nondestructive testing of aircraft and missile components, Hilton Hotel, San Antonio, Texas

Feb. 18–20

NSPE, winter meeting, Broadview Hotel, Wichita, Kan.

Feb. 24–26

AMA, special conference on planning new products, Drake Hotel, Chicago, Ill.

Feb. 29–March 2

AMA, Data Processing Conference and exhibit, Statler-Hilton Hotel, New York, N. Y.

March 7–9

Association of Iron and Steel Engineers, western meeting, St. Francis Hotel, San Francisco, Calif.

March 7–11

American Society of Civil Engineers, New Orleans Convention, Jung Hotel, New Orleans, La.

March 14–16

American Railway Engineering Association, annual convention, Sherman Hotel, Chicago, Ill.

(*For ASME Coming Events see page 135*)

National Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

ASME Design Engineering Conference and Design Engineering Show to Be Held in New York Coliseum, May 23–26

- Conference Subjects to include Space-Age design, theory, and techniques
- 375 companies already signed for exhibits at show

APPLICATION of space-age design theory and techniques to new products for the home and factory will be the subject of the Design Engineering Conference, which will be held concurrently with the Design Engineering Show, May 23 through 26, at the New York Coliseum, New York, N. Y. The conference will consider advances made in power, control, materials, computers, components, and mechanics to determine how everyday products may be improved.

The Design Engineering Show, an exposition devoted to the research and development of new products, will occupy all four floors of the New York Coliseum during a four-day run there, May 23 to 26.

The Conference

The conference will be sponsored by the Machine Design Division of The American Society of Mechanical Engineers.

The first day will be devoted to "New Horizons in Engineering Design." This will be a panel discussion of design authorities in nuclear and space technology. They will give brief talks and answer audience questions to indicate how new design principles, relationships, and formulas developed for their fields can be applied to commercial products.

Speakers will give special attention to applications of materials and components to meet extremes of environmental conditions and to achieve the ultimate in performance. High temperatures, low temperatures, erosion, corrosion, impact, vibrations, miniaturization, reliability, and limited life will be among the items discussed.

Sessions on power and control will consider "Reliability Predictions," "Impact of Reliability on Design," and "Analysis of Control Systems." Sessions on materials will hear papers on "New Welding Processes," "Metal Part Fabrication by Explosives," "Some Characteristics of High-Strength Steels" and "Composite Materials." Mechanical sessions will be devoted to "Hydraulic Components for Extreme Service," "Fluids and Seals for Extreme Service," "Modular Dimensioning for Automatic Assembly," and "Basic Design Parameters for Automatic Assembly."

A final session, by a panel, will discuss "Use of Computers in Design."

The Show

Three hundred and seventy-five nationally known companies already have contracted for exhibit space and it is expected that the final number will be well over 400, according to Clapp & Poliak, Inc., New York, the exposition management firm which produces the event.

The twin events were last held in New York in 1957. The show is one of the largest industrial expositions in the country.

Although admission is limited to those with major responsibilities for the design of new products, more than 20,000 major executives and engineers are expected to attend. Materials and component parts for virtually every type of product—from commonplace household articles to interplanetary space ships—will be shown. There is scarcely a major manufacturing company in the nation which does not send representatives to the show.

On exhibit will be hundreds of metal alloys, plastics, synthetic and natural rubbers, power-transmission equipment, electrical and electronic components, mechanical components, various shapes and forms, fasteners and adhesives, finishes and coatings, hydraulic and pneumatic components, engineering equipment and services, and almost everything else which goes into the making of industrial or consumer end products.

Visitors who wish show or conference information, hotel reservations, or rapid registration cards should write Clapp & Poliak, Inc., 341 Madison Avenue, New York 17, N. Y.

ASME Spring Lubricaton Symposium to Be Held in New York City

THE Lubrication Division of The American Society of Mechanical Engineers, in co-operation with the Metropolitan Section, will conduct a two-day symposium on "The Load-Carrying Capacity of Bearings" in the Auditorium of the Engineering Societies Building, 29 W. 39th Street, New York City, on March 14 and 15, 1960.

This symposium will be the third in this annual series which is designed to furnish a forum for the discussion of specific problem areas in the field of lubrication. Previous symposiums have dealt with "The Role of Viscosity in Lubrication" and "Wear of Lubricated Surfaces."

Subject matter for this meeting will include aspects of bearing design, the influence of application and environmental factors, and the properties of load capacity. Application to rolling element, journal, and thrust bearings will be discussed in the symposium.

Specialists in the field have been invited to participate. The program will consist principally of informal presentations by persons who are actively working in the areas they discuss; there will be ample opportunity for full discussion from the floor.

▶ MONDAY, MARCH 14

Session 1—Design Parameters 9:30 a.m

Chairman: *W. J. Anderson*, NASA, Cleveland, Ohio

Inertia Effects on Hydrostatic Thrust Bearings, by *D. Dowson*, Univ. of Leeds, Leeds, England

A Note on the Influence of Elastic Compliance on Sliding Friction in Ball Bearings, by *K. L. Johnson*, Cambridge Univ., Cambridge, England

Effect of Stabilization Temperature on Ball Bearing Fatigue Life, by *A. S. Irwin*, Marlin-Rockwell Corp., Jamestown, N. Y.

Rolling Contact Fatigue Studies With Four Tool Steels and Crystallized Glass Ceramic, by *E. B. Zaretsky* and *W. J. Anderson*, NASA, Cleveland, Ohio

Increased Capacity for Roller Bearings of the Future, by *M. E. Otterbein*, Hyatt Bearings Div., GMC, Harrison, N. J.

Session 2—Application and Environmental Factors 2:00 p.m.

Chairman: *G. B. Grim*, Caterpillar Tractor Co., Peoria, Ill.

Control of Oil-Whip Frequency Ratio, by *E. H. Hull*, Gen. Elec. Co., Schenectady, N. Y.

The Effect of Vibration on the Load-Carrying Capacity of Parallel Surface-Thrust Bearings, by *A. Nahavandi* and *F. Osterle*, Carnegie Inst. of Tech., Pittsburgh, Pa.

Lubricant Effects—Temperature, Pressure, and Contamination, by *T. Osters*, Cleveland Graphite Bronze Co., Cleveland, Ohio

Lubricant Effects—Method of Application, by *J. M. Robertson*, Bohn Aluminum & Brass Co., Detroit, Mich.

Vibration and Other Disturbances, by *F. Osterle*, Carnegie Inst. of Tech., Pittsburgh, Pa.

▶ TUESDAY, MARCH 15

Session 3—Physical Properties of Lubricants 9:30 a.m.

Chairman: *W. A. Wright*, Sun Oil Co., Marcus Hook Pa.

Hydrocarbon Structure and Its Relation to Temperature and Pressure Effects on Viscosity, by *J. A. Dixon*, Pennsylvania State Univ., University Park, Pa.

Viscosity—Temperature Relationship and Their Application, by *W. A. Wright*, Sun Oil Co., Marcus Hook, Pa.

Shear and Time Effects—Problem Areas in Lubrication Theory, by *H. A. Hartung*, Atlantic Refining Co., Philadelphia, Pa.

Session 4—Chemical and Physical-Chemical Properties of Lubricants 2:00 p.m.

Chairman: *R. Q. Sharpe*, Mobil Oil Co., New York, N. Y.

The Effect of Chemical Properties of MoS_2 on Frictional Behavior, by *A. J. Haltner*, Gen. Elec. Co., Schenectady, N. Y.

Influence of Chemically Active Additives on Boundary Lubrication, by *a major oil co. representative*

Effectiveness of Physically Adsorbed Additives in Boundary Lubrication, by *a major oil co. representative*

RESEARCH

First Systems Research Center

A RECENT million-dollar grant from the Ford Foundation is making possible the establishment of the first Systems Research Center at Case Institute of Technology. Under the direction of Dr. Donald P. Eckman, professor of instrumentation engineering, the center will pioneer in graduate education stressing the areas of theory, communication, control, optimization, reliability, and the important areas of human behavior which affect the operation of systems. Systems under study will range from complex automatic computers controlling large industrial plants to simple budgeting methods.

The goal of systems engineering is to determine how an over-all system may be improved to do the best possible job. The Center will bring together all the skills of the various engineering disciplines in addition to the resources of the basic sciences, the social sciences, and the humanities.

1960 ASME Textile Engineering Conference March 31–April 1 at North Carolina State College

THE third Annual ASME Textile Engineering Division Southern Conference will be held at North Carolina State College, Raleigh, N. C., March 31–April 1, 1960. Though the Conference is young in age, the attendance has appreciably increased each year and this year shows promise for continued growth. The program may be divided into two themes: Advances in Engineering, as they pertain to the Textile Industry; and Advances in Textiles, as they pertain to the engineer.

The first theme will include timely subjects in water pollution, natural gas in the textile industry, the design of treatment plants, and preventive maintenance.

The second theme will include presentations on textile processes, modern trends in the production of bulked yarns, and direct spinning.

Make your plans now to enjoy a program which shows promise of being one of the better offerings anywhere and renew acquaintances at the Social Hour and Banquet.

▶THURSDAY, MARCH 31

Authors' Breakfast 8:00 a.m.

Registration 8:00 a.m.–12 noon

Session 1 9:30 a.m.

Water Resources and Stream Pollution Control,[1] by *E. C. Hubbard*, North Carolina Dept. of Water Resources, Raleigh, N. C.

Textile Waste Treatment—What to Do About It, by *J. L. Brown, Jr.*, Cannon Mills Co., Kannapolis, N. C. (Paper No. 60—TEX-2)

Panel Discussion—Engineering Aspects in Design of Treatment, by *J. L. Brown, Jr.*, Cannon Mills Co., Kannapolis, N. C.; *E. C. Hubbard*, Dept. of Water Resources, Raleigh, N. C.; and *C. W. Mengel*, William C. Olsen and Associates, Raleigh, N. C.

Luncheon 12:45 p.m.

Session 2 2:00 p.m.

Natural Gas in the Textile Industry,[1] by *J. Sellers*, Bryant Industrial, Cleveland, Ohio

Maintenance Records Simplified, by *J. H. Boddie*, Mount Vern Mills, Inc., Tallahassee, Ala., (Paper No. 60—TEX-1)

[1] Paper not available—see box on this page.

Ordering Papers By Mail

NUMBERED papers to be presented will be available in separate copy form until Jan. 1, 1961. Copies can be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. The numbered papers are priced at 40 cents each to ASME members and 80 cents to nonmembers, but will be on sale at the Conference to all delegates at 40 cents. Papers ordered by mail must be designated by the numbers listed in the program, otherwise the order will be returned.

Some Observations on Textile Automation,[1] by *C. M. Asbill, Jr.*, School of Textiles, North Carolina State College

Social Hour 6:00 p.m.
Banquet 7:00 p.m.

▶FRIDAY, APRIL 1
Authors' Breakfast 8:00 a.m.

[1] Paper not available—see box on page 132.

Registration 8:00 a.m.
Session 3 9:30 a.m.

Trends in the Production of Continuous Filament Textured Yarns,[1] by *R. E. Wiggins*, School of Textiles, North Carolina State College

Panel Discussion—Spinning From Silver, by *R. Dalton, Jr.*, Whitin Machine Works, Whitinsville, Mass.; *H. J. Burnham*, Saco-Lowell Shops Research Center, Clemson, S. C.; *E. Koella, Jr.*, Rockford Mfg. Co., Rockford, Tenn.; and *F. E. Boseman*, Atkinson, Haserick and Co., Clarksville, Ga.

Creativity and Engineering Management Discussed at ASME San Francisco Section Conference

At the Ninth Annual Professional Divisions Conference of the San Francisco Section of The American Society of Mechanical Engineers, held recently, one of the technical papers was entitled "Engineering Management as Related to Profit and Creativity." The author, John D. Kemper, is Vice-President—Engineering, Marchant Division, Smith-Corona Marchant, Inc., Oakland, Calif. In his paper, Mr. Kemper made certain points bearing on the current discussions of the creative individual, particularly the creative engineer.

Rewards for Invention. Mr. Kemper stated that in most U. S. corporations today a nominal award is made to an inventor upon application and granting of a patent. Such awards are usually not so large that undue competition among engineers is encountered in a scramble after them. However, he said, there appears to be present in the world a trend in the direction of much more substantial rewards for inventors. Some companies have experimented with plans which provide royalties to inventors depending upon the profits which accrue from their inventions.

"Western Germany," he said, "enacted a law in 1957 relating to employee inventions which grants almost miraculous powers to an inventor, securing for him considerable financial awards. For example, this law requires that the employer either proceed to patent and commercially develop any invention made by one of its employees or to release same to the employee. Thereupon, the invention can be freely offered among all bidders, including competitors. If the employer wants the invention, then he must negotiate and pay for it.

"Furthermore, when the product begins to accrue profit, the employee and employer enter into new negotiations to determine the amount of further financial reward that the employee is to receive. If the employee is dissatisfied with the offer, he can appeal to a government board which will settle the amount by arbitration."

Such a philosophy obviously holds that the invention is the whole thing, and that subsequent activities are only the "skill of the artisan." We can think of instances where a good idea has gone astray because of poor implementation on its way to the production line. Given a system where outstanding financial rewards go to the possessor of a patent, what chance have you got of asking a man who is broadly gifted to do anything other than work which might garner him unusual financial returns?

Yet the implementation process must be staffed by outstanding people, just as well as the earlier phases of the creative process....There are the mechanical designers....There is "the entire chain of effort leading from the conception of a device to its delivery to the customer.

This means that invention is an essential, but only a component, part of the creative process." The quotation is from J. F. Young of General Electric, Mechanical Engineering, December, 1945.

Group Action. Mr. Kemper pointed out that relatively recent enactments of law have tended to recognize the fact that technological progress is more likely to result from the efforts of a group than from what has been called the individual "flash of genius." The flash-of-genius test was invented by the U. S. Supreme Court, and for many years was used as the primary test as to an invention's patentability, but the Patent Codification Act now states that: "Patentability shall not be negatived by the manner in which the invention was made." Thus, group achievement is recognized.

"The 'hard work' aspect of creativity is one that needs to be emphasized," he said. "Creative people agree that many hours of concentration and deliberate creative effort are required before inspiration finally strikes. This checks with Edison's oft-quoted remark that creation is one per cent inspiration and 99 per cent perspiration. There is another quotable saying that 'inspiration most often strikes those who are hard at work'."

Thus we have a concept that supercedes the flash-of-genius idea, that grants that most of the advances of history and in science and in the field of mechanics have been the result of long study and step-by-step advance, mostly by group processes. Within such groups we have two dominant types of individuals, the one oriented toward concepts, needs, ideas; the other more oriented to the requirements of hardware, his day consisting of an endless chain of bit-by-bit acts of creation. We have been ready since childhood for almost instant recognition of the talents and worth of the former man, and feel an innate apathy toward the latter.

He said: "If the end goal, the success and ultimate profitability of a product, is to be most efficiently attained, individuals must be able to work in the group structure without dissension and struggle as to who is going to get the gravy. Competent individuals must be turned in directions which not only fit their own capabilities, but also meet the requirements of the organization, in the sure knowledge that their contributions will receive proper recognition. It is only in that way that we can achieve a hormonious structure, which is a basic necessity for efficient group action."

Mr. Kemper listed the following books and articles as useful reading on this subject: J. F. Young, "Developing Creative Engineers,"* Mechanical Engineering, December, 1945; T. E. Shea, "An Industrial Point of View on Creative Engineering,"* Mechanical Engineering, May, 1949; Edwin C. Nevis, "What is a Creative Designer?" *Machine Design*, Dec. 25, 1958; George V. Woodling, "Inventions and Their Protection," Clark Boardman Company, Ltd., New York, N. Y., and Mathew Bender & Company, Inc., Albany, N. Y., 1954, 2nd edition; William H. Easton, "Creative Thinking and How to Develop It,"* Mechanical Engineering, August, 1946; "Design Is Your Business," Small Business Administration, Washington, D. C., November, 1953; Philip Marvin, "Planning New Products," The Penton Publishing Company, Cleveland, Ohio, 1958; and J. F. Downie Smith, "The Potential Machine Designer," Mechanical Engineering, February, 1958.

* These three articles have been reprinted, along with several others, in a pamphlet entitled: "Creative Engineering." This is available through the ASME Order Department, 29 West 39th Street, New York 18, N. Y., at $1 a copy; 20 per cent discount to ASME members.

Conducted for the National Junior Committee

J.R. BERENDES[1]

JUNIOR FORUM

Professional Registration

By A. S. Goldstein[2]

PROFESSIONAL Registration is something most young engineers have heard about but not many have considered seriously. Most of us are involved in work which does not require a professional engineer's license and our future careers do not seem to depend upon licensing. However, the facts about licensing indicate that professional registration may be more meaningful to us than just a framed certificate.

Since 1907, professional engineering registration laws have been enacted in all states. In the early 1930's there were only 10,000 registered professional engineers and now there are over 200,000. Registration now makes available the mechanism toward developing a meaningful distinction between those qualified and those who improperly call themselves engineers. Here is an opportunity to raise the standards of the engineering profession through legal sanction just as medicine and law now enjoy.

At this point, your reaction might be that professionalism is a nice concept about which you've heard many noble words but which does not concern or affect you directly. Let's see how you can benefit materially from professional registration.

Professional Registration. Registration may or may not mean more money in your paycheck depending upon the personnel policies of your employer. However, registration in many firms is considered a factor in evaluating employees for promotion, more responsible work, and more opportunities for individual thought and discretion. Increased compensation usually accompanies these in a short while. A survey conducted by the Schenectady General Electric Engineer's Association of more than 2000 members of that group shows that registered professional engineers enjoy an advantage both salary wise and position wise. The statistics show a man with the PE license receives $2000 to $2500 a year more in salary in the age level above 40 years, and below 40 the advantage is $500 to $1000 a year.

Benefits of Registration. A further benefit of registration is legal acknowledgment that the person with a license has a specified degree of competence and has demonstrated his qualifications. It has been held in the courts that a person cannot collect a fee on a contract for the rendition of engineering services unless he is a registered engineer. It has also been held that a person is unqualified to testify in judicial proceedings as an expert witness on engineering matters unless he is a registered professional engineer. Many states and municipal governments have passed statutes, ordinances, and rulings which require that certain governmental engineering positions be filled only by registered professional engineers. In addition, professional registration is recognized by your fellow engineers as a significant achievement.

Again your attitude may be that "these things are not of interest to me." However, do you know the future opportunities which might arise that involve professional registration? The effort required to become a registered professional engineer has been increasing and is expected to increase further. Requirements are being upgraded in most states. Every industrial employer would

[1] Sales Representative, Combustion Engineering, Inc., Chicago, Ill. Assoc. Mem. ASME.

[2] Engineering Writer, General Electric Advanced Electronics Center at Cornell University, Ithaca, N. Y. Assoc. Mem. ASME.

Chairman's Corner

An Open Letter to a Young Associate Member:

Dear Tom,

It was good to talk with you during our "Junior Session" at the Annual Meeting in Atlantic City. The National Junior Committee was formed in 1947 to encourage professional development among young ME's. The session you attended and the Junior Forum articles in MECHANICAL ENGINEERING are the results of some of the work of the Committee. Another phase of the Committee's work has been the establishment of Junior Representative posts on most of the Regional and national ASME committees. A more recent development has been the formation of "Young Associates Committees." These committees have organized panels of young mechanical engineers who have gone to the campuses in their sections to describe their jobs to the undergrads and to let them in on what they might expect in their future job situations. Another Associates Committee activity has been to personally contact each new graduate and bring him to the Section meetings. A Region-wide technical paper contest is another Young Associates Committee activity. These programs and others have, for the most part, been conceived by a Regional Committee and have been carried out by the Section Committees. In Regions V and VI each Section Young Associates Committee sends two delegates to the regional "YAC."

You expressed your interest in becoming more active in ASME. You can see that there are many ways you can become active. Nominations are open from now until March 31 for Junior Representative positions on the Student Sections, Membership Development, and Civic Affairs Committees in all the Regions. You may prefer to work on the Young Associates Committee in your Region. In any case, please contact either your Regional vice-president or me.

We would also be pleased to have you attend any of our National Junior Committee meetings. The next one will be at Society headquarters in New York City, 10:00 a.m., Saturday, February 27.

N. J. Viehmann,[3]
Chairman,
National Junior Committee

[3] Product Engineer, Dept. 142, Western Electric Company, North Andover, Mass.

like to have all his qualified engineers become registered. A recent survey indicates that over 75 per cent of industrial employers actively encourage their engineers to become registered. It enhances the firm's reputation to have large numbers of registered professional engineers on its staff. You can be sure that professional registration will not hurt your future opportunities.

Personal Satisfaction. There is one more aspect of registration which I consider the most important advantage. That is the personal satisfaction that I have been judged by my peers to be qualified as a professional engineer. This may not bring me material advantages, but it will be the fulfillment of a personal goal that is the most important reason for professional registration.

Now, if you are convinced or feel that there is an advantage to becoming a registered engineer, the next question is—how do you go about it? The requirements for registration in each state are exclusively within the control of the state legislature. Many states have reciprocal agreements for recognizing licenses from other states. However, it can be stated generally that most state laws require graduation from an accredited engineering curriculum, followed by approximately four years of responsible engineering experience, plus the successful completion of an oral and/or written examination. Most states permit the substitution of practical experience for formal education but this "Grandfather clause" is becoming an obsolete practice.

Many states also have provisions for granting preregistration certificates to those persons who have not yet attained the requsite experience for full registration. These are generally known as "Engineer-in-Training" registrations, the requirements for which are usually graduation from an accredited engineering curriculum and the successful completion of an examination on fundamental engineering subjects. It is important to obtain an EIT certificate as soon as possible. Most state boards will recognize the EIT certificate of another state, which is based upon successful completion of a written examination.

The best manner of obtaining the details of professional registration is to write to the engineering registration board of the state in which you desire to become licensed. Two years ago "Junior Forum" listed the addresses of several registration boards each month. If you wish, write to N. J. Viehmann, Chairman, National Junior Committee, 62 Walnut Avenue, Andover, Mass., for the address of the state board in which you are interested.

You also can contact your state Society of Professional Engineers or its local affiliated chapter for information. In addition, many companies that encourage registration have the information you need.

Remember that it is best to become registered as soon as possible after graduation. There are refresher courses for professional registration examinations sponsored by companies, professional societies, and private individuals. Registration will cost you a nominal fee and requires some effort, but the return in the future may far exceed your expectations.

ASME COMING EVENTS

March 6–9
ASME Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Texas.

March 14–15
ASME Lubrication Symposium, Engineering Societies Building, New York, N. Y.

March 29–31
American Power Conference, Hotel Sherman, Chicago, Ill.

March 31–April 1
ASME Textile Engineering Conference, North Carolina State College, Raleigh, N. C.

April 4–8
Nuclear Congress and Exhibit, Coliseum, New York, N. Y.

April 7–8
ASME-SAM Management Conference, Statler Hilton Hotel, New York, N. Y.

April 20–21
ASME-AIEE Railroad Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

April 25–26
ASME Maintenance and Plant Engineering Conference, Chase-Park Plaza Hotels, St. Louis, Mo.

April 25–29
ASME Metals Engineering Division-AWS Conference, Hotel Biltmore, Los Angeles, Calif.

May 17–19
ASME Production Engineering Conference, Hotel Schroeder, Milwaukee, Wis.

May 22–26
ASME Oil and Gas Power Conference and Exhibit, Muehlebach Hotel, Kansas City, Mo.

May 23–26
ASME Design Engineering Conference and Show, Coliseum, New York, N. Y.

June 5–10
ASME Summer Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, Texas.

June 20–22
ASME Applied Mechanics Conference, The Pennsylvania State University, University Park, Pa.

June 27–29
ASME West Coast Applied Mechanics Conference, The California Institute of Technology, Pasadena, Calif.

August 15–17
ASME-AIChE Heat Transfer Conference and Exhibit, Statler Hilton Hotel, Buffalo, N. Y.

September 7–9
ASME Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Mass.

September 15–16
ASME-AIEE Engineering Management Conference, Morrison Hotel, Chicago, Ill.

September 21–23
ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.

September 26–28
ASME Petroleum Mechanical Engineering Conference, Jung Hotel, New Orleans, La.

October 9–12
ASME Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa.

October 17–19
ASME–ASLE Lubrication Conference, Statler Hilton Hotel, Boston, Mass.

October 24–25
ASME–AIME Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.

November 27–December 2
ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(For Meetings of Other Societies see page 130)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers 50 cents; to ASME Members, free.

ASME Solar Energy Applications Committee Chairman meets with officers of Japan Society of Mechanical Engineers. **Left to right:** Ihachiro Tanaka, Vice-President for Technical Affairs, JSME; J. I. Yellott, Mem. ASME, and Chairman, Solar Energy Applications Committee; Prof. Ichimatsu Tamishita, Keio University, Chairman, Committee on Applied Solar Energy, JSME; Prof. Ichiro Watanabe, Keio University, Vice-President, JSME; Dr. Katsumi Okuda, Direction and Manager, Technical Department, Metsubishi Shipbuilding and Engineering Company, Ltd., Vice-President, JSME; and Prof. Yohei Kiducler, University of Tokyo, Editor of JSME Publications.

American and Japanese Authorities Discuss Solar Energy Applications at Conference in Tokyo

DURING a recent trip to Japan, John I. Yellott attended a round-table conference held with the Japan Society of Mechanical Engineers at the Marunouchi Building, Chiyoda-ku. Purpose of the Conference: To discuss problems of mutual interest between The American Society of Mechanical Engineers and JSME.

Dr. Yellott, owner of the firm of John I. Yellott Associates, Phoenix, Ariz., is an internationally recognized authority on the uses of solar energy and has participated from the very start in ASME activities in this field.

Presiding at the conference was Dr. Ichiro Watanabe, Senior Vice-President of JSME, and Professor of mechanical engineering at Keio University, Tokyo.

Solar Energy in Japan. Particular attention was paid to the work of the committees on Solar/Energy Application which have been formed by both Societies. Dr. Ichimatsu Tanashita, past vice-president of JSME and head of the Department of Mechanical Engineering at Keio University, as Chairman of the JSME Solar Energy Committee, reported that his committee is co-ordinating solar energy work in all fields in Japan, largely due to the fact that membership in the JSME is held by virtually all who are working in the thermal, electrical, and photochemical aspects of solar energy.

Mr. Yellott, speaking for the ASME Solar Energy Committee, pointed out that mechanical engineers only now are beginning to take real interest in the field of solar energy, primarily as a result of the space program.

Other research programs were discussed, including work on the properties of steam being carried out by Professor Tanashita at pressures up to 15,000 psi and temperatures up to 1800 C.

Facts About JSME. It was learned that the JSME annual meeting is held in April and is attended by somewhat more than 2000 members. The total membership in the Society is approximately 25,000 members.

Most of the publications of the Society, which are edited by Dr. Yohei Kokuchi of the University of Tokyo, are printed in Japanese. However, since 1958, the Society has been publishing *The Bulletin of JSME* in English. This publication is now being distributed widely throughout the English-speaking nations of the world and its technical quality is highly esteemed in professional circles.

There are 28 technical divisions of the JSME, operating in the following fields: Strength of Materials, Materials, Dynamics, Machine Elements, Hydraulics and Hydraulic Machineries, Compressors and Blowers, Heat and Thermodynamics (Solar Energy Committee), Fuel and Combustion, Lubrication, Steam Power Plants, Internal-Combustion Engines, Automobile Machinery, Railway Engineering, Transportation Machinery, Precision Machinery, Machine Tools, Foundry, Welding, Plastic Treatment, Refrigeration and Air Conditioning, Textile Machinery, Marine Products, Chemical Machinery, Industrial Machinery, Production Control, Automatic Control, Aeronautics, Instrumentation. The Nuclear Energy Committee is still a "talking committee."

Research subcommittees of ten to fifteen members, who meet once a month, are appointed for two-year terms. There are approximately 30 of these.

The meeting began and ended with the serving of tea, a rite which is obligatory at all Japanese functions.

ASME CODES AND STANDARDS WORKSHOP

Interpretations of 1955 Code for Pressure Piping

FROM time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinions of the Committee.

Pending revision of the Code for Pressure Piping, ASA B31.1–1955, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Cases No. 38, No. 43, and No. 44 are published herewith as an interim action of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

B31 EXECUTIVE COMMITTEE HONORS MARTINI—The Executive Committee of the B31 Code for Pressure Piping, meeting November 17–18, honored C. C. Martini for his work on Section 3, Petroleum Refinery Piping, and for his recent service as chairman of Subcommittee 3. Overseas assignment required Mr. Martini to resign. Those present, **left to right:** W. S. Martyn; H. M. Cooley; J. P. Mooney, Mem. ASME, vice-chairman; G. R. Locke, Mem. ASME; D. W. Motter; C. C. Martini; Manuel Gutierrez, ASME staff; Lindsay Stewart; F. S. G. Williams, Fellow ASME, chairman; R. V. Warrick, Mem. ASME; R. G. Bateman; E. J. Wiseman, Mem. ASME; A. H. Cramer; W. R. Steur, Mem. ASME; M. B. Conviser; T. J. Miller; W. R. Gall, Mem. ASME; K. W. Haupt. Mem. ASME; O. W. Heyden. Also present but not shown were: J. R. Chamberlain; J. J. Kanter, Mem. ASME; E. A. McPhillamy; and Frank Philippbar, ASME staff.

Case No. 38 (Reopened)

Inquiry: May piping components made of Nodular Cast Iron and to the dimensions of ASA Standards B16.1, B16b, B16.5, and API 600 be used in construction under the jurisdiction of Sections 1, 2, and 3 of the Code for Pressure Piping (ASA B31.1–1955)?

Reply: It is the opinion of the Committee that, pending the completion of studies now in progress in Sectional Committee B16 and B31, Nodular Cast Iron components made of material conforming to ASTM Specification A395–56T may be used under the Sections indicated in the Inquiry under the following conditions:

(a) Components whose dimensions conform to ASA B16.1, B16b, B16.5, and API 600 may be used at the following maximum pressure-temperature ratings at temperatures between minus 20 F and 650 F.

DIMENSIONS USED	MAXIMUM RATING
Class 125 C. I. (B-16.1)	80% of 150 lb Carbon Steel
Class 250 C. I. (B-16b)	80% of 300 lb Carbon Steel
150 to 600 lb Steel, inclusive (B16.5 or API 600)	80% of Carbon Steel rating

These ratings are applicable to valves providing that the values in other respects merit these ratings. It is recognized that components made to the Class 125 and Class 250 standards or to API Std. 600 may be thicker than those made to the 150-lb and 300-lb standards, respectively. In the case of these thicker components the additional wall thickness may be considered as additional corrosion allowance.

(b) Until further experience is developed, the pressure at operating temperature shall not exceed 1000 psi.

(c) Welding is not employed either in fabrication of the components or in their assembly as a part of a piping system.

(d) They shall not be used in lethal service.

Case No. 43

Inquiry: Paragraph 155, Section 1 of ASA B31 as now written appears unduly restrictive for high pressure fuel oil piping, in requiring that it be designated as for saturated steam at the operating pressure.

May the design of such systems, using only steel components, utilize those components covered by B16.5–1957 at the pressure-temperature ratings given therein, using the actual fluid temperature as the design temperature?

Reply: It is the opinion of the committee that fuel oil piping using only steel components may be designed to utilize those components under the adjusted pressure-temperature ratings of B16.5–1957, using the actual fluid temperature as the design temperature.

Case No. 44

Inquiry: The latest edition of Section 1, ASA B31 is 1955. In view of the extensive re-evaluation that has taken place since that time, what joint factors may be applied to fusion welded pipe made to ASTM Specifications A-155 or A-358 fully radiographed?

Reply: Pending publication of the next edition of ASA B31.1, it is the opinion of the Committee that the intent of the Code will be met if a joint factor of 1.0 is used for pipe made under specifications in which the pipe has been fully radiographed as required by these specifications.

Cases Annulled

Case Nos. 18, 19, 20, 22, 30, and 33.

The following Cases are to be annulled *only as they apply to Section 3:*

Case Nos. 8, 10, 11, 14, 27, and 29.

Vertical Drilling Machines

By A. Cervenka, Chairman B5–TC-25

THE American Society of Mechanical Engineers will shortly be issuing a new American Standard Accuracy of Vertical Drilling Machines, ASA B5., which should be approved by the American Standards Association soon.

This American Standard includes Vertical Drilling Machines of the box and round column types. It excludes radial drilling machines, special purpose drilling equipment, and machines using fully universal tables (tilt, rotate, swivel, etc.).

The purpose of this standard is to provide a basic set of acceptance tolerances to be used by builders and users. Users of drilling equipment will, when keeping to ASA Standards, be assured of a basic quality in every machine, without having to run costly evaluation tests; will benefit from inherent first-cost monetary savings, and will continue to benefit by virtue of lower maintenance and better performance during the economic life span of the machine.

The builders will have a greater uniformity of product, without the loss of propriety; the producer of submarginal equipment will find it necessary to upgrade his product, thereby giving the

R. P. Hoelscher, **right,** Southern Illinois University visiting professor of applied science, shows the Certificate of Award he received from The American Society of Mechanical Engineers to Dr. Ralph O. Gallington, acting head of the SIU School of Applied Science. The award, made at the Society's Annual Meeting in Atlantic City, N. J., expresses appreciation to Professor Hoelscher for "outstanding leadership" in the development of Standards and Codes, in engineering drawing, sponsored by ASME. Professor Hoelscher, who retired last summer as head of the University of Illinois general engineering department, was an active participant in the Sectional Committee Y14 for 15 years, serving as chairman for ten years. He is serving as a visiting professor at SIU during the current school year.

entire industry a more uniform, stable, and competitive mode and atmosphere of operation.

The specification was prepared by Technical Committee #25, operating under Sectional Committee B5, whose membership is composed of technical people from both users' and builders' companies.

Sponsors of the project are American Society of Tool Engineers, National Machine Tool Builders' Association, Metal Cutting Tool Institute, Society of Automotive Engineers, The American Society of Mechanical Engineers.

Petroleum Refinery Piping

The following errors in Section 3, Petroleum Refinery Piping, of the Code for Pressure Piping, have been called to the attention of the committee.

1 Page 56, table 302.31B, next to last item should read 2¼ Cr. 1 Mo. instead of 2½ Cr. 1 Mo.

2 Page 56, table 302.31B, last item should read 5 Cr. ½ Mo. A-357, instead of A-387.

3 Page 58, table 302.31B, eighth item from top should read 5 Cr. ½ Mo. A-357, instead of A-387.

ASME Elects Ten to Grade of Fellow

The American Society of Mechanical Engineers has honored ten of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow, one must be an engineer with acknowledged engineering attainment, have 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and be a Member of the Society for 13 years. Promotion to the grade of Fellows is made only on nomination by five Fellows or Members of the Society to the Council, to be approved by Council.

The men who were so honored for their outstanding contributions to their profession and to the Society are:

W. W. Oakley

Walter Weckerle Oakley, retired chief engineer, Corning Glass Works, Corning, N. Y., initiated the design of many innovations in glass-melting furnaces. These include all types of combustion systems, regenerators, refractory manufacture, and other developments which, though not patented, have contributed greatly to the technology of glass furnaces. Also, he supervised the development and manufacture of many novel refractories for use in the glass industry, particularly zircon, chrome, and fused aluminum. He holds patents for cooling bridge walls of glass-melting furnaces, a method of melting glass, and glass-melting tank structures. Mr. Oakley has been with Corning since 1917; he was chief engineer since 1940, and in 1959 he retired. Under his direction, Corning Glass Works designed and installed plants and structures in the amount of $50 million. Mr. Oakley served the Society as a member of the Nominating Committee of the Southern Tier, New York State Section. He is a Fellow also of the American Ceramic Society and member of the Society of Glass Technology. He is a registered professional engineer in the State of New York. He is past district governor of District 712 Rotary International and past-president of the Rotary Club of Corning, N. Y.; also treasurer of Corning Hospital for 13 years.

A. H. Senner

Arthur Henry Senner has had a career marked by distinguished engineering achievement ranging from pioneer work on domestic oil burners to development of gas turbines for naval use. Currently, he is on the faculty of the Baltimore Polytechnic Institute, a post which he assumed after his retirement as head of the Mechanical Engineering Department of the U. S. Naval Engineering Experiment Station, Annapolis, Md. While there, Mr. Senner had been responsible for the testing and improvement of the first large (3500 hp) gas turbine. He was in charge also of the testing and evaluation of the first installation of a gas turbine in a U. S. Navy vessel. In 1952, to meet the Navy's requirement for a more compact power plant for submarines, Mr. Senner supervised the testing and development of a system using hydrogen peroxide as an oxidant. These are but a few of his accomplishments. He is the author of numerous papers on many subjects related to thermodynamics. He holds two patents on combustion and heat-transfer devices. Mr. Senner is a registered professional engineer in the State of Maryland.

K. W. Stinson

Karl Willson Stinson, professor of mechanical engineering, The Ohio State University, has made numerous significant contributions in the field of engineering education. In addition, he has done considerable research and development work in fields relating to engines, pumps, hoists, design methods, and such. Professor Stinson has also done much to advance the role of the internal-combustion engine through his writing, teaching, designing, and consulting services. He joined the faculty at Ohio State in 1921 and in 1934 was named professor of mechanical engineering. During this period also he acted as assistant chief engineer for Seagrave Corporation, designing and developing engines and pumps, frames, transmissions, and the like. He has been employed, also on a consulting basis, by the American Chain Corporation, Columbus McKinnon Chain Corporation, Panhandle Eastern Pipe Line Company, and others. During World War I, Professor Stinson served as an instructor in the U. S. Army Air Corps, Aviation Ground School. In World War II, he was director of the U. S. Navy Pilot Training Program and the Navy Diesel School at Ohio State. He is coauthor with M. L. Smith of a textbook, "Fuels and Combustion," McGraw-Hill Publishing Company, 1952, and is the author of a "Diesel Engineering Handbook 1959." In addition, he has written numerous papers for the technical press. He holds three patents. Professor Stinson has served the Society as a member of the Oil and Gas Power Division Executive Committee for five years. He was Division chairman in 1952–1953. He is a member of Sigma Xi and Pi Tau Sigma, and also belongs to the following professional societies: SAE, AIME, AOA, ASEE. He is a fellow also of AAAS. He is a registered professional engineer in the State of Ohio.

Nevin L. Bean

Nevin L. Bean is technical assistant to the Divisional Staff Manufacturing and Plant Engineering Manager, Automatic Transmission and Chassis Division, Ford Motor Company, Livonia, Mich. He has been with Ford since 1920. His work there—on transfer-type machines, in-line dip painting and drying machines, on carbide cutting programs, and on machine motorization—has often been pioneering work and has served as a guide and a stimulant for similar work in other industries. Mr. Bean is a recognized authority on the design and planning of special machinery for mass production and automation. His published works on the subject have appeared in *Machinery*, *Iron Age*, *The Tool Engineer*, and Mechanical Engineering. During

World War II, Mr. Bean held a number of special assignments including work on an aircraft-engine program, and was a War Production Board consultant. He has been an active member of ASME having served a term as chairman of the Production Engineering Division and as committee chairman of the Detroit Section. In Detroit Section work he has been concerned with Vocational Guidance. He was technical consultant at the International Conference on Automation held in Paris in 1957 and sponsored by the European Production Activity of the Organization for European Economic Co-operation. In December, 1955, Mr. Bean was among three American engineers selected to tour the USSR on an exchange basis to study and report on Russian developments in automation and production engineering. He has since been invited to deliver his impressions of Russia on radio, television, and before numerous educational and technical groups. He is a registered professional engineer in the State of Michigan.

Henrik Ovesen

HENRIK OVESEN, consulting engineer, was born in 1886 in Denmark, where he received his education. He came to the United States in 1909. He began working at Standard Steel Car Company in Butler, Pa., and in 1915 went to Homestead Steel Works. Later he was employed by the American Sheet and Tin Plate Company, and from 1920 to 1922 he was engineer in charge of building Apollo Steel Company's extension. In 1922 Ovesen became assistant chief engineer and later chief engineer for the Youngstown Sheet and Tube Company. In 1927–1928 he built one of the first high-pressure boiler plants in a steel works. Since 1935 Ovesen has been consulting engineer for various companies in the United States and Canada and also has built or assisted steel works in England, Denmark, Sweden, and France. During World War II Ovesen was in China to help boost the steel production there. In 1952 he introduced the L-D Oxygen Converter in the U. S. Currently in his work with Dravo Corporation, Pittsburgh, Pa., he is introducing a still more economical way to replace open hearths, namely, the Kaldo process. Ovesen is a member of the American Iron and Steel Institute, British Iron and Steel Institution, Verein Deutscher Eisenhütten, Danish Engineering Society, American Steel Mill Engineers, and Swedish Iernkouter. He is a registered professional engineer in the State of Ohio. In 1948 the King of Denmark made him Knight of Dannebrog.

R. R. Slaymaker

ROBERT RIDGLEY SLAYMAKER is professor of machine design at the Case Institute of Technology, Cleveland, Ohio, and an engineering consultant for the Cleveland Graphite Bronze Division of the Clevite Corporation. At Case since 1937, Professor Slaymaker has supervised the teaching of all courses in machine design and related subjects. During the period 1943–1947, he was dean of the Junior Division, and from 1947–1950 he was acting head of the department of engineering administration. He is the author of two books, "Bearing Lubrication Analysis" and "Mechanical Design and Analysis," both published by John Wiley & Sons, Inc. A specialist in the field of bearings and lubrication, he has done valuable research on subjects such as thermal expansion of bearing housings, "crush" in connecting rod bearings, and such. Professor Slaymaker is a member also of ASLE and ASEE as well as Sigma Tau and Sigma Xi. He is a registered professional engineer in the State of Ohio.

R. R. Tucker

RAYMOND ROCHE TUCKER, Mayor of the City of St. Louis (Mo.), has brought to his office an unemotional engineering approach which has helped to guide the city through a period of new growth. His election in 1953 was hailed by engineers and citizens alike as an important step toward efficient management of the city's affairs. His re-election in 1957 by a large plurality reaffirmed this confidence. Mayor Tucker was elected to office while he was head of the department of mechanical engineering at Washington University. But he was not new to the field of public administration, since he had been Secretary to the Mayor of St. Louis, 1934–1937; Commissioner of Smoke Regulation and Director of Public Safety, 1937–1942; and Director of Civil Defense, 1953. His work for smoke abatement in St. Louis was controversial but highly successful, and was such that cities troubled by similar problems called upon him for consulting advice. His early career (1921–1934) was as a faculty member in the mechanical-engineering department at Washington University. His achievements have been recognized by numerous groups and on many occasions he has been honored. Both St. Louis University and Washington University have conferred honorary LLD degrees upon him. In 1956, he received the Achievement Award Medal of the Engineers Club of St. Louis. In 1957, St. Louis University presented him with its Alumni Merit Award, and he received the Mound City Press Award. The Richard Mellon Award of the Air Pollution Control Association was also given to him in that year, and he received the Man of the Month Award of the St. Louis Advertising Club in February, 1957. Mayor Tucker received the St. Louis Award in 1956 for his outstanding civic leadership. He was the first Mayor to receive this top award. Mayor Tucker is the author of works on smoke abatement and was a contributor to a series published in *Heating, Piping, and Air Conditioning* on "A Smoke Program That Worked." He is a member of Sigma Xi and Tau Beta Pi.

H. L. Mason

HENRY LEA MASON, assistant chief, Analog Systems Section, National Bureau of Standards, has earned international recognition for his research work. Dr. Mason has been at NBS since 1952, serving as a specialist in the field of servomechanisms and automatic-control systems. In his current position, he is part of the data-processing systems group, in charge of the NBS analog computer and its application to the Bureau's scientific problems. Prior to joining the Bureau's staff, he had taught at Rutgers, Columbia, and Iowa State College. At Ames he developed a novel test cell for measuring the thermal conductivity of liquids. Before going to Ames he had been director of research at Taylor Instrument Company, Rochester, N. Y. His work has led to the issuance of a number of patents in his name. Among them are a time-saving sphygmomanometer cuff, a governor, a pressure gage, and a mass flowmeter. Several of his papers, ranging from impact on beams to the conversion of cardiographic data, have been published in the *Transactions of the ASME* and in the technical press. He is also the translator of a German book, "Dynamics of Automatic Controls," by R. C. Oldenbourg and H. Sartorius, published by ASME. In the Society, Dr. Mason served for two years as chairman of the Executive Committee of the Instruments and Regulators Division. In addition, he served as the first secretary of the Research Committee on Mechanical Pressure Elements. In both of these areas he has made extensive contributions—in one case to automatic control terminology and, in the other, an important study of the performance of Bourdon tubes. He has represented IRD on the Research Planning Committee, and is currently a member of ASME Research Executive Committee. He is a memer of ASEE, ISA, and the Washington Philosophical Society; and of Phi Beta Kappa, Sigma Xi, and Tau Beta Pi. A registered professional engineer in the

State of New York, Dr. Mason is presently active in terminology standardization for automatic controls in the American Standards Association and the International Federation for Automatic Control.

W. R. Spiller

WILLIAM RAYMOND SPILLER, vice-president in charge of engineering, Harris-Intertype Corporation, Cleveland, Ohio, is one of the country's leading authorities on printing and publishing equipment. His career has been exclusively with manufacturing firms and his activities have been mainly in the area of creative development of new and improved products. He has been with Harris-Intertype (previously Harris-Seybold Company) since 1939 when he headed all design, development, and engineering activities. During World War II, he guided the firm's complete conversion to war work. Part of this work was the design and manufacture of the highly effective "Shoran" bombing computer. In recent years, Mr. Spiller has directed his efforts toward the modernization of engineering systems, toward intensified research and development programs, and toward the establishment of central research laboratories working with decentralized engineering departments at all plants. He is inventor or co-inventor of 34 patents pertaining to printing machinery. He has made several contributions to the engineering literature. Mr. Spiller is a member also of AOA, of the Cleveland Engineering Society, Lithographic Technical Foundation, and the Research and Engineering Council of the Graphic Arts Industry. In addition to his professional activities, he is a member of the St. Alexis Hospital Advisory Board and an associate member of the Inter-Society Color Council. He is a registered professional engineer in the State of Ohio.

B. F. Langer

BERNARD F. LANGER, consulting engineer, Bettis Atomic Power Laboratory, Westinghouse Electric Corporation Pittsburgh, Pa., is recognized for his outstanding work in the dynamics of electric locomotives resulting in safety and low track maintenance at increased speeds; for his contributions in the petroleum and marine fields; and for his ingenuity and thoroughness in special instrument development. In addition, since 1949 when he moved to the Bettis laboratory, he has aided in the design and development of nuclear plants for the atomic submarines *Nautilus*, *Skate*, and *Skipjack*. Mr. Langer has made significant contributions in the developing of mathematical models concerning complex problems in mechanics, dynamics, stress analysis, and high-impact shock; and then applying the model to obtain a practical solution or design technique. His accomplishments in these fields are witnessed by the number of patents—26—which he holds jointly or independently. The 23 papers of which he is author or co-author, published in journals of ASME and other societies and in the technical press, range in subject matter from "The Measurement of Locomotive Wheel Loading" to "Experimental Mechanics of Nuclear Power Reactors." In 1941 Mr. Langer, who had been with Westinghouse since 1928, received the company's Order of Merit. He has served the Society as a member of the Special Committee on Nuclear Power of the Boiler and Pressure Vessel Committee, and on numerous task groups connected with Boiler and Pressure Vessel Code activities. He has served also on the Nuclear Engineering Division Papers Review Committee and on the ASME Program Committee for the 1959 Nuclear Congress. He is a member also of the Society for Experimental Stress Analysis, ANS, ASTM, and the Pressure Vessel Research Committee of the Welding Research Council.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
(Agency)

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 per cent of the first year's salary if a nonmember, or 4 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

NEW YORK	CHICAGO	SAN FRANCISO
8 West 40 St.	29 East Madison St.	57 Post St.

Men Available[1]

New York Office

Chief Engineer or Assistant Chief Engineer, ME; 22 years in the engineering department of a manufacturer of valves; five years assistant chief engineer; four years chief engineer; one year director of research. $12,000. New England. Me-778.

Mechanical Engineer, January, 1960, graduate, BME; interested in heat and power, nuclear reactor design. New York Metropolitan area or East. Me-799.

Engineer, BSME; 33; speaks English, German, Spanish; for operations in Latin America, or to cover American manufacturers' interest in potential European common market. Experience includes consulting plant engineer, senior project engineer; special machinery, hydropower plants, product design and development, extensive machine-shop practice. Me-780.

General Manager, metal fabrication or engineering services; MS; 35; partner and president, engineering services and consulting firms three years; general sales manager, district sales manager, product manager, heavy metal fabricators and contractors seven years; engineering project manager; and instructor at academic institutions, four years. $20,000. East, Far West. Me-781.

Plant Maintenance Engineer or Plant Engineer, BSME; 31; seven years' experience in plant-maintenance engineering; two years' experience in manufacturing, production, and quality-control engineering. $8400. East, South, or Midwest. Me-782.

[1] All men listed hold some form of ASME membership.

Export Sales Administrator, BME and MME; 15 years' experience; ten years foreign sales heavy machinery to industrial, utilities, and engineering organizations, mostly Latin America; knowledge of export procedures. Willing to travel. Salary open. New York City or Conn. Me-783.

Chicago Office

Chief Engineer; 46; 22 years' experience in engineering supervision of mechanical, ordance, and general design engineering. Background of automated machine development; engineering for production, research, and development; industrial engineering and cost control. Midwest or West. Me-1029-Chicago.

Mechanical Engineer, BSME, MBA, June, 1960; 32; desires smaller organization where experience and training will be of value. Two years machine shop; six years project engineer and research, design, development, installation, operation food-processing equipment. Location optional. Me-1031-Chicago.

San Francisco Office

Manager on Sales Engineer, MSME, 35, PE, Ind., Ill., and Ala. Two years self-employed as consultant. Five years' experience professor engineering and manager of research for university. Seven years sales manager on metal fabrication. $15,000–20,000. Prefers West, Midwest. Home: Ala. Se-1881.

Mechanical Designer, 46, 22 years' experience mechanical design of fork-life trucks, guns, machinery, auto motors, water turbines, piping, tools. $5400 up. Prefers San Francisco or Calif. Home: San Francisco. Se-1855.

Designer, ME (London), 34. Eight years' experience design, draft cigarette-making and packaging machines, oxygen-cutting equipment,

gas turbines. $7000. Prefers West Coast or Detroit. Home: San Francisco. Se-1854.

Chief Plant or Construction Engineer. ME, 52, PE, Calif. Experienced supervisor of design, construction, and preventive maintenance of industrial plants and public works. $10,000. Prefers Pacific Coast, Foreign. Home: Calif. Se-1807.

Manufacturing Engineer, 38, 11 years' experience tooling, processing, facilities, and industrial method work. Good with people and has knowledge of shop experience. $9600. Prefers Calif. Home: Mich. Se-1595.

Manager, Director, ME, 44, PE. Over 22 years in product development and manufacturing covering design, prototype development, testing, research, production, materials, fabrication techniques. Missile propulsion, aircraft structures, automotive vehicles. Proved manager, organizer, executive. $16,000–$18,000. Prefers Los Angeles, Calif., or any. Home: Calif. Se-1844.

Designer, ME, 36. Capable of running small office, client contact, over-all planning, estimates, supervising detailed design for heating, ventilation, air conditioning, plumbing, electric distribution, lighting of commercial buildings. $10,500. Prefers San Francisco East Bay. Home: Calif. Se-1797.

Production Manager, ME, MBA, 35, ten years in engineering production and design plastics, marine, air transportation, cement, automotive. $13,500 minimum. Prefers Calif. or New England. Home: Calif. Se-1796.

Electromechanical Designer. ME training, 28. Five years' experience design, draft electromechanical packaging, machine, piping, equipment for electronic firms and aircraft manufacturer. $8700. Prefers San Francisco Bay area. Home: San Francisco. Se-366.

Plant Engineer, ME, 52. Licensed W. Va., 30 years' experience, study, direct plans for modernization, plant layouts, estimates for electric cable, metals, atomic energy, and chemical plants. $15,000. Any U. S. location. Home: East. Se-1762.

Mechanical or Project Engineer, 50. Over 25 years' experience steam-power plant design and construction. Mechanical and electrical background in power, water treatment, instrumentation. Ten years' consulting engineering office supervision. $12,000. Prefers San Francisco Bay area, foreign. Se-1705.

Sales Engineer, ME, 38. Seven years selling services and products, valuable in closing sales, schedules and reporting on industrial construction and installation, plus inspection of industrial plants, processes development, familiarity with mechanical equipment and materials. Accounting and auditing experience useful in small or large selling organization. $7000. Prefers East or San Francisco Peninsula. Home: Calif. Se-1719.

Sales Manager, 15 years successful administration, experienced planning, organization, and directing national sales specialized technical equipment to industries, municipalities, government agencies. Machining, welding, and steel-fabrication experience. $15,000. Any location. Home: N. Y. Se-376.

Designer, ME, 61. Wide experience in design and field with large industry, contractors, and consulting engineers, know power plant, piping, heating, air conditioning, and plumbing. Extensive foreign experience. $10,200. Prefers Western U. S., foreign. Home: Calif. Se-1706.

Production Manager, ME, 53. PME, Calif., 28 years' experience division manager, vice-president, works manager on machine tools, aircraft manufacturing. $18,000. Prefers Calif., foreign. Home: S.Calif. Se-1676.

Mechanical or Project Engineer. 50. Over 25 years' experience steam-power plant design and construction. Mechanical and electric background in power, water treatment, instrumentation. Ten years consulting engineering office supervision. $12,000. Prefers San Francisco Bay area, foreign. Se-1705.

Design, Development. MSME, 42. Sound engineering background and administrative ability, 13 years varied manufacturing design, shop sales, customers and technical societies liaison, mechanical and hydraulic equipment, instrument and medium-sized mechanisms, fluid flow, hydraulic controls, metallurgical. $9600–12,000. Prefers San Francisco Bay area. Home: Calif. Se-1605.

Maintenance, Design, ME, 50. Licensed N. Y. Five years' experience design of metal furnaces, hydraulics, machinery to manufacture wood products, diesel engines; 11 years maintenance, design for aluminum production, plant

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME _____ FIRST NAME _____ MIDDLE NAME _____

POSITION TITLE _____ NATURE OF WORK DONE _____

e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) _____ Division, if any _____

*☐

EMPLOYER'S ADDRESS _____ City _____ Zone _____ State _____

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐

HOME ADDRESS _____ City _____ Zone _____ State _____

☐

PRIOR HOME ADDRESS _____ City _____ Zone _____ State _____

* CHECK "FOR MAIL" ADDRESS

Address changes effective when received prior to:

I subscribe to

- ☐ MECHANICAL ENGINEERING — 10th of preceding month
- ☐ *Journal of Engineering for Power*
- ☐ *Journal of Engineering for Industry*
- ☐ *Journal of Heat Transfer*
- ☐ *Journal of Basic Engineering* — 20th of preceding month
- ☐ *Journal of Applied Mechanics*
- ☐ *Applied Mechanics Reviews* — 1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

- ☐ A—Aviation
- ☐ B—Applied Mechanics
- ☐ C—Management
- ☐ D—Materials Handling
- ☐ E—Oil and Gas Power
- ☐ F—Fuels
- ☐ G—Safety
- ☐ H—Hydraulics
- ☐ I—Human Factors Group
- ☐ J—Metals Engineering
- ☐ K—Heat Transfer
- ☐ L—Process Industries
- ☐ M—Production Engineering
- ☐ N—Machine Design
- ☐ O—Lubrication
- ☐ P—Petroleum
- ☐ Q—Nuclear Engineering
- ☐ R—Railroad
- ☐ S—Power
- ☐ T—Textile
- ☐ U—Maintenance and Plant Engineering
- ☐ V—Gas Turbine Power
- ☐ W—Wood Industries
- ☐ Y—Rubber and Plastics
- ☐ Z—Instruments and Regulators

Additional listings of positions and men available are maintained in the offices of E.S.P.S. Direct inquiries to nearest office. A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members; $4.50 per quarter or $14 per annum for nonmembers, payable in advance.

expansion; five years inspection of naval materials; three years test and inspection of ammonia, air, and freon compressors. Salary open. Prefers Pacific Coast, Home: East. Se-1791.

Positions Available

New York Office

Plant Engineer, mechanical graduate, at least five years' supervisor plant engineering and maintenance experience in brewing, distilling, or allied food-processing industries, including considerable refrigeration. $10,000–$12,000. Western Pa. W-8436.

Research and Development Engineer, graduate mechanical, for a consulting-engineering laboratory; experienced in applied mechanics, experimental stress analysis, vibrations, and instrumentation. Master's degree and two or three years' experience desirable. Mass. W-8434.

Industrial Management Engineer, 35–45, for work with a well-known industrial-management consulting firm. Must have five to ten years' experience in industrial engineering. Some travel. $9000–$12,000. Headquarters, New York, N.Y. W-8429.

Mechanical Engineer, small component-design experience on electronic equipment; extensive knowledge of materials; fluid mechanics and related fields. Salary open. Midwest and East Coast. W-8417.

Chief Development Engineer, graduate mechanical, to head up a program of machine-tool development. Must be and have experience in creative machine-tool design. To $15,000. Southern New England. W-8413.

Machine-Tool Engineer, mechanical graduate, 20 years' design, development, and tooling experience covering machine tools and light machinery to set up and conduct shop and school-training program. $14,000, plus allowance; two-year contract. India. F-8412.

Design-Development Engineer, ME degree, approximately three years' experience in design-development work on special purpose, high speed, automatic machinery. Responsible for developing and designing new machinery or process units in the extruded plastics field; will design and expedite fabrication and assembly of new machinery, conduct pilot production operation on these machines. Open. Conn. W-8407.

Chief Engineer, mechanical or chemical-engineering graduate, ten years' experience in chemical-process equipment design and application, i.e., liquid agitators, blenders, ball mills, pressure vessels, etc. Salary high. Ohio. W-8398.

Teaching Personnel for mechanical engineering. Needed in fields of fluids, heat transfer, thermodynamics, aerodynamics, in the theoretical and applied mechanics area, and in nuclear engineering. Large and rapidly growing graduate program through DSc. Sponsored research encouraged. No limitations on rank. Salary and rank commensurate with educational background and experience. Southwest. W-8394.

Associate Industrial Engineers, preferably advanced degree, and having completed formal 120-hr work-factory course. Experience with high-volume electronic equipment desired. To $8600, ample fringe benefits. Central N. J. W-8379.

Mechanical Engineer, ME degree, industrial research experience, for a new research laboratory. Will involve research and development work in the field of mechanical processing of fibrous systems. Excellent facilities and equipment. Salary open; above average pension plan and employee benefits. Prefer Canadians or Americans from northeastern U. S. Eastern Canada. F-8372.

Mechanical Engineer, graduate, ten years' experience, five of which have been on heating, ventilating, and air-conditioning design and layout, to 500 tons, commercial and industrial. Some experience in sanitary, plumbing, and piping, and/or hydraulic mechanisms desirable. $8500 up. New York, N.Y. W-8370.

Chief Equipments Engineer, graduate mechanical, 34–49, experience in the design and development of precision, continuous operation processing equipment requiring close technical control of quality; management and supervision of engineering functions; paper, photographic, color printing or related industries. Will direct and supervise the design, development, and procurement (including construction and/or installation) of processing equipment for precision coating and packaging of plastic and other base films. Direct and supervise the maintenance and improvement of equipment. $10,000–$14,000. Conn. W-8363.

District Sales Manager, mechanical engineer, experienced in mechanical power transmissions, chains, sprockets, couplings, speed reducers, etc. About $12,000, plus commission. Territory, Metropolitan New York, northern N. J., and Conn. Headquarters, northern N.J. Similar openings in Detroit, Michigan, and Houston, Texas. Company will negotiate placement fees. W-8361.

Sales Engineers, pulp-and-paper school graduates, definite sales ability. Must be familiar with paper mills, either through actual paper-making experience or through selling a product directly to the mills. N.Y. State. W-8357.

Industrial Engineer, graduate, approximately five years' experience in wage-incentive installations, based upon standard data, material-handling methods, plant layout, statistical quality-control and work-sampling (ratio-delay) techniques, for responsible position in IE department. Excellent benefits and advancement opportunities. Central N.J. W-8354.

Works Manager, 35–48, degree in mechanical or industrial engineering, ten or more years' experience in a small or medium-sized well-managed company mass producing small metal products or units, preferably fasteners. Must have a basic understanding of production control, labor relations, plant layout, wage rates and incentives, budgetary control, material handling, and quality control. $10,000–$15,000, fringe benefits. Suburban N.Y. W-8347.

Cabinet Engineer, graduate mechanical, three to five years' related experience, for the development and product engineering on freezer and combination refrigeration-freezer product lines. Must be familiar with cabinet fabrication methods, machine components design, such as die castings, rolled and extruded metal, ejected molded vacuum forms, extruded plastic insulation and cabinet sealing, good gaskets, handles, etc. Should be familiar with proper materials to use in all foregoing applications. $8000–$10,000. N. Y. State. W-8339.

Air-Conditioning, Heating, and Ventilating Engineer, ME degree; specialist in air conditioning, ventilation, primarily to industrial plants, for new designs or redesigns for air conditioning, ventilating, and other related items such as fume removal, cooling systems, dust removal, etc. Will co-ordinate company layouts with other engineering groups; prepare estimates on cost of air-conditioning and ventilating systems; follow installation in the field. $9600–$12,000. New York, N.Y. W-8338.

Professor, Assistant Professor, or Instructor for ME Department; master's degree or PhD, interested in teaching thermodynamics or machine design or both. Available September, 1960. Rank and salary open, dependent on qualifications. Upstate N. Y. W-8328.

Automotive Manufacturers Engineer, mechanical or industrial engineering degree, who has worked in transmission or engine plant, to design production lines specified by machine tools and equipment for new products to be put in production tests within six months or a year. Must be experienced in automation. $10,000–$12,000. N. J. W-8317.

Chief Development Engineer for a manufacturer of felts and industrial fabrics. Must have good engineering know-how; be a good administrator; and have a sound knowledge of electronics and experience with textile equipment. Will be responsible for developing machinery and machinery equipment to improve manufacturing, reduce cost of manufacturing, etc. Open. N. Y. State. W-8316.

Senior Engineer, Applied Mechanics, recent graduate MS or PhD, or several years' experience. Analytical ability desired. Position is with small consulting firm doing business in wide variety of fields, including missile and submarine-vibration problems. Open. Relocation costs paid. Mass. W-8149.

Chicago Office

Pump Designers, graduate mechanical, at least two years' experience in design and development work. Work will be on the design of impellers and large centrifugal pumps. Can use men with from two to ten years' experience. $6600–$9600, depending upon experience. Employer will pay fee. Wis. C-7844.

Engineers. (a) Chief engineer, graduate mechanical or electrical, several years' experience directing design and development department of small company manufacturing complex electro-mechanical industrial equipment. Should have good understanding of manufacturing shop practices and equipment installation and service problems. Should have good judgment of product development and an understanding of the economic and manufacturing problems of several fields such as packaging, drying, or materials-handling where complex electrical, mechanical, and hydraulic controls are used. Will direct a small group of creative practical designers and engineers in developing a new line of products and working out the details of developments under way. Good potential; company manufactures textile machinery and equipment. To $12,000. Employer will pay fee. (b) Design engineer, graduate, several years' experience in design of electromechanical industrial equipment. Should be able to design machine components to fit existing facilities and understand the relationship between market and manufacturing costs. Experience in several facets of product development. Company plans on entering new areas of industry and is developing new devices for present markets. Must be flexible and be capable of working closely with sales and management but main duties will be design of new products for a textile machinery manufacturer. To $9000. Employer will pay fee. Sixty miles from Chicago. Ill. C-7829.

Research and Development Engineers or **Physicists,** BS or better, from none to considerable experience in research and development. Under direction will conduct experimental investigations of radically new processes and products in the field of packaging utilizing metal, paper, plastic, glass, and other materials. Must be U. S. citizen and draft exempt. From $6000, depending upon experience. Employer will pay fee. Chicago, Ill. C-7838.

San Francisco Office

Estimators, preferably experienced with estimating costs relating to job-shop fabricating of steel, heavy machinery, and machined equipment. $6600–$7800, and up; depending on experience. For manufacturer. San Francisco North Bay. Sj-4954.

Sales Engineer, ME, to 50. Recent and substantial experience in the application, engineering, and sale of mechanical packing and textiles. Should be able to handle a branch office and take care of and expand a developed territory. For a national manufacturer. $8000 upward, plus bonus, expenses; car required. Los Angeles. Sj-4952.

Sales, Service Engineer, mechanical background, 30–55. Qualified by recent and extensive experience in dealing with sales installation service of pumps and pumping systems for households, farms, agriculture processing, and other users. Should be able to sell and service to farmers, industries, cities, irrigation districts. For manufacturer's agent of turbines, centrifugals, domestic, and submersible pumps. Developed territory. Opportunity to share in business. Compensation for consideration. Tulare County. Sj-4949.

Mechanical Designers, ME; minimum five years' experience involving mechanical stress analysis, layout, drafting; knowledge of machine-shop practices, assembly work, sheetmetal, shop work, and fabrication. Will assist in design, development of mobile automotive electrically operated material-handling equipment involving structural, mechanical, electrical, and some body and chassis work. For a manufacturer. $6600–$7800. San Francisco East Bay. Sj-4947.

Maintenance Superintendent, six to ten years' experience maintenance, construction, design, or operation of water-works facilities; or repair or installation of mechanical or electrical facilities, including pumps, electric motors and allied control mechanisms, or plant-production equipment. To direct maintenance and installation, repair and servicing of pumps, electric motors, automatic control equipment, automotive and heavy construction equipment, metal parts, small frame and concrete structures. Under manager of operations and maintenance. $10,400–$11,600. Must be U. S. citizen. San Francisco East Bay. Sj-4945.

Senior Mechanical Designer, MSME desirable, five to ten years' in actual design of precision instrumentation such as gyros, transducers, electromechanical instruments. $12,000–$16,000. San Francisco Peninsula. Sj-4941.

Supervising Operator, ME or EE. Qualified by recent and substantial experience to operate and supervise operation of a hydroelectric generating plant and distribution of electric power. Should be an American with experience with General Electric or Westinghouse turbogenerating equipment and qualified to provide superintendency of all personnel plus continuing contact with government administration. Must be able to pass an overseas physical and provide substantial references and have liking for living in warm overseas country. $12,000 plus subsistence and housing. Transportation furnished. Sj-4937.

Sales Engineer. MinE or ME, young. Experienced in both surface and underground

drilling for a good understanding of hydraulic and compressed air. Able to analyze special application and able to recommend proper equipment. Also able to conduct distributor's sales meetings and meet top management personnel. Free to travel. For a national manufacturer. Salary commensurate. Sj-4936.

Engineers. (*a*) Design engineer, mining, civil, or mechanical degree preferred, with previous industrial design experience in connection with mining, ore dressing and smelting or refining plants, equipment and facilities. $7200–$10,200. (*b*) Construction Engineer, CE or ME, with previous experience in directing or coordinating plant construction work, preferably with nonferrous smelting plants. $7200–$10,200. (*c*) Estimator, MinE, Met, or ME, broad experience in heavy industrial construction and engineering estimating, preferably mining and mineral industry; qualified to make cost estimates on project budgetary and appropriation estimates; supervise small group. Salary open, plus benefits. Western U. S. Sj-4928-R.

Industrial Engineers, IE or equivalent, 33–43. Eight to ten years' experience preferably related to operations of large merchandising company in time studies, methods analyses, store and warehouse layouts, industrial relations, etc. Well-balanced individual with initiative, as industrial engineer member of engineering staff; work with managers of maintenance, warehousing, construction for large chain store. $8000–$10,000. San Francisco Peninsula. Sj-4928.

Teacher, minimum requirements, MSME. Teaching and professional experience desirable, but not required. Rank and salary depends on education and experience. Pacific Island. Sj-4922.

Estimator-Engineer, at least two years' college training, any age. Responsible for engineering, writing, and distribution of orders and quotations; design help for customers, cost and preparation of orders, time and cost studies, estimating and maintenance of records. $5400–$9000; for spring manufacturer. San Francisco. Sj-4924.

Senior Designer, ME, eight to 15 years' experience design and supervising design for chemical petroleum or petrochemical plants. Able to handle self-contained project of various kinds related to improvement, extension, and maintenance of engineer designed services, from preliminary design through detailing to end. $9000–$11,400. San Francisco North Bay. Sj-4917-R.

Product Design, ME, minimum of five years' production design, about 30–35. Design products to customer requirements; machinery, steel, gears, transmissions, power drives. For manufacturer. $7800–$8400. San Francisco Peninsula. Sj-4914.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after Feb. 25, 1960, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Transfers

Alabama

FRANCIS, WILLIAM H., Auburn

Arizona

● DINGLE, JOHN T., Phoenix

California

● DEMOCSKONYI, ERWIN S., Anaheim
● DUTTON, RICHARD A., Northridge
ENGLER, MARTIN R., JR., Bonita
GALLAGHER, BRIAN M., San Diego
GILL, AJIT S., Burbank
HARVEY, DONALD W., Los Angeles
● HOLCOMB, LOWELL A., Ontario
KRIEBEL, ANTHONY R., Menlo Park
● SCHUMACHER, DONALD R., Concord
SUZUKI, STEVE T., San Francisco
TIPTON, ALVONZO G., Manhattan Beach
WALLING, JOHN C., San Francisco

Connecticut

BENTSEN, BIRGER A., Wallingford
BERLIN, ROBERT E., W. Hartford
BRANCART, CLAUDE P., Niantic
HUTNIK, MICHAEL J., Meriden
ORAVEC, EMIL G., New Haven
VAN DORN, HORACE B., New Britain
WATSON, BRUCE M., Hartford

District of Columbia

HERTELENDY, PAUL, Washington

Delaware

● HECKROTTE, ROBERT S., Wilmington

Florida

HENDERSON, CHARLES D., Miami
● O'NEAL, ELLIS H., Miami

Idaho

● ARBTIN, EMIL, JR., Idaho Falls
GUKEISEN, CHARLES A., Idaho Falls
TAXELIUS, THOMAS G., Idaho Falls

Illinois

BASTA, ROBERT E., Chicago
DAIVA, KRISHNAKUMAR M., Freeport
ENGBERG, JOHN W. L., Downers Grove
HAGEMEIER, DWIGHT F., Aurora
HALL, STANLEY G., Urbana
● KETCHPEL, PAUL A., JR., Park Forest
PIERCE, SUMMER L., Chicago
● SHAFFER, ROBERT K., Chicago Heights
WILLIAMS, CHARLES J., Decatur

Indiana

BESSELSEN, CLARENCE, Fort Wayne
● ULRICH, WOODROW, Hagerstown

Iowa

● TEMPLE, PHILIP A., Muscatine

Louisiana

THOMAS, HENRY A., Baton Rouge

Maryland

FIELD, FRANK A., JR., Baltimore
● NOOKER, EUGENE L., Silver Spring

Massachusetts

ANDERSON, DUNCAN W., Needham
BLATT, THOMAS A., Cambridge
GOLDSCHMIED, FABIO R., Boston
OTTO, PAUL W., Springfield
TREKELL, HAROLD E., Lynn

Michigan

CHERBAS, THOMAS, Battle Creek
DEBAEKE, PAUL V., Grosse Pointe
KEYES, JOHN M., Allen Park
NARLOCK, RONALD J., Jackson

Missouri

FOSTER, NEWTON S., JR., Clayton
ROBBINS, WALSH C., St. Louis
TURNER, EARL J., St. Louis
VANDERWAL, PAUL H., St. Louis

Montana

COUGHREN, KENNETH D., Missoula

New Jersey

ALLERTON, ROBERT W., Harrison
FOX, WALTER D., Closter
LEDEEN, JULIAN I., Maplewood
● STAMPER, EUGENE, Teaneck
WALKER, MARVIN J., Camden

New York

ADISE, HERBERT H., Great Neck
BOCCACCIO, ANTHONY A., Bethpage
FINNELL, WILLIAM J., Long Island City
GERSTENHABER, JULIUS, Poughkeepsie
HALPERN, ERNST, Plainview
● HANDEN, CARL, Poughkeepsie
KALB, JOHN V., Beacon
KOFF, WILLIAM, New York
MOLLER, FREDERICK J., New York
RAJECKAS, GEDIMINAS, Maspeth
SEDO, LESLIE, New York
WATERMAN, JAMES C., Wellsville
WATSON, EDWIN B., Sidney
WEGSCHEIDER, JENS J., Hempstead
WOLLE, AUBERY B., Scarsdale

North Carolina

LEE, WILLIAM S., Charlotte
MONTAGUE, EDGAR B., JR., Charlotte
MORGAN, WILLIAM F., Winston Salem
● SERRELL, MORTON A., Charlotte

Ohio

CAMPBELL, REED W., E. Liverpool
CASTLE, CHARLES H., Cleveland
DICKERSON, ROGER W., JR., Cincinnati
DUFFEY, DONN W., Dayton
● EVANS, JOHN B., Willoughby
HEPBURN, WILLIAM M., Toledo
HOFER, RICHARD F., Cincinnati
KELLER, PARRY, JR., Cleveland
● LEJK, JOSEPH R., Dayton
LOESCH, ROBERT A., Cuyahoga Falls
● MERRILL, KARL R., Dayton
● MUSCARELL, ROBERT V., Dayton
MYERS, JOSEPH P., Columbus
ONDRAKE, ANDREW J., Cincinnati
REITZ, JOHN G., Willoughby
SHICK, ALVIN W., Mount Vernon
STOCK, JOHN R., Cleveland
WEISEND, BURKE A., Cleveland
YOST, WELDON H., Toledo

Oklahoma

THOMAS, ROBERT W., Tulsa

Pennsylvania

ALBERT, ROLPH, Orangeville
● EVERETT, JAMES L., Aldan-Clifton Heights
● FISCHER, WILLIAM H., Avalon
FRYE, ROBERT D., Erie
GRAEF, JOHN B., E. Pittsburgh
● LADY, EDWARD R., Allentown
LEIGH, ARTHUR B., Chester
LEYLAND, GORDON B., Springfield
MANTIA, THOMAS A., Pittsburgh
MONACO, EUGENE G., Lester
STABLES, GORDON, JR., Philadelphia

Rhode Island

SWANN, EDWARD J., N. Scituate

Tennessee

COWHERD, JACKIE R., Old Hickory

Texas

BLACK, WILLIAM F., JR., Fort Worth
COOMBS, GILBERT G., Texas City
● FLOYD, MONROE, Dallas
HOLLAN, JOHN C., JR., Fort Worth
NATHO, PAUL J., Houston
NOYES, THEODORE A., College Station
PARDUE, GEORGE H., JR., Houston
● STRANGE, LLOYD K., Dallas
WHITE, SHELDON C., Dallas

Virginia

HAYNES, ALEXANDER H., Hampton
SHAFFER, PAUL R., Denbigh

Washington

BALTRUSCH, ROGER M., College Place
● JAMES, RICHARD G., Richland
● WADE, GENTRY E., Richland

West Virginia

CHASTAIN, STANLEY J., Huntington
● KAIL, LEONARD A., Charleston

Wisconsin

AHUJA, BALDEV K., Madison
WARRENDER, ROBERT T., Kenosha

Foreign

ADRIAENSSENS, JEAN A., Dublin, Ireland
ALBERTO H. B., Caracas, Venezuela
CARTER, ALLEN M., Toronto, Ont., Canada
CARTER, ANTHONY B., Brecon, S. Wales, Gr. Britain
FARIA, LUCIANO L. O., Lisbon, Portugal
KOHRING, WALTER, Battlesbridge, Essex, England
● LAWSON, STANLEY P., Johannesburg, South Africa
LAWTON, FREDERIC L., Montreal, Que., Canada
ORLIK, WIESLAW F., Ontario, Canada
TUDELA, RAFAEL, Caracas, Venezuela
UREN, WILLIAM S., Camborne, Cornwall, England

● Transfer to Member or Affiliate.

OBITUARIES

Harry Holborn Angus (1881–1959), head of H. H. Angus and Associates, Consulting Engineers, Toronto, Ont., Canada, died Nov. 3, 1959. Born, London, Ont., Canada, Dec. 19, 1881; youngest son of the late Robert Angus who was one of the earliest members in Canada of ASME. Education, B. Ap. Sc. in Mechanical and Electrical Engineering, University of Toronto, 1904. Mem. ASME, 1919. The firm Mr. Angus headed specialized in design and supervision during con-

struction of the mechanical and electrical equipment and ventilation of buildings, and in general power-plant work. He was a past-chairman of the ASME Ontario Section; past-president and director, Association of Consulting Engineers of Canada; member of Associations of Professional Engineers of Ontario (one of its founders) and of Alberta; member of Engineering Institute of Canada; and past-chairman of ASHVE Ontario Section. Survived by wife, Blanche Mowat; two sons, Donald L. of Toronto and Gordon L. of Winnipeg; and his brother Robert W. Angus, Hon. Mem. ASME.

J. Chester Bath (1892–1959), vice-president and treasurer, John Bath & Co., Inc., Worcester, Mass., died Oct. 19, 1959. Born, Hyde Park, Mass., May 23, 1892. Education, Fitchburg Trade School, 1912. Mem. ASME, 1953. Mr. Bath had been with the firm which manufactures ground thread taps, plug and ring thread gages, and internal micrometers. Mr. Bath served the Society as a member of the Committee on Standardization and Unification of Screw Threads (B1) and the Standardization Committee on Small Tools and Machine Tool Elements (B5).

John George Bellas (1935–1959), lieutenant, U. S. Air Force, Bartow Air Force Base, Fla., died Sept. 5, 1959, in an airplane accident in South Hadley Falls, Mass., while taking private flying lessons. Born, Springfield, Mass., July 26, 1935. Education, BS(ME), Univ. of Massachusetts, 1958. Assoc. Mem. ASME, 1958.

Nyle Albers Bischel (1934–1959), trainee, The Babcock & Wilcox Co., Lynchburg, Va., died Oct. 30, 1959, in an air accident. Born, Harvey, Ill., Dec. 14, 1934. Education, BS(ME), Purdue Univ., 1956. Assoc. Mem. ASME, 1946. Survived by his parents, Mr. and Mrs. Kermit L. Bischel, Kankakee, Ill.

Kavasji Kharshedji Bhappu (1871–1959?), whose death recently was reported to the Society, had been a partner in the Crystal Ice and Cold Storage Co., Karachi (Pakistan). Born, Anklesvar, Bombay Presidency, India. Education, LME, Victoria Jubilee Technical Institute, 1891. Assoc. Mem. 1921; Mem. ASME, 1935. Mr. Bhappu had been with the Crystal Ice and Cold Storage Co. since 1917. He was a specialist in the field of refrigeration.

Alfred J. Buchi (1879–1959), 1937 ASME Melville Medallist and chairman of the board, Dr. Alfred J. Buchi Ltd., Winterthur, Switzerland, died Oct. 27, 1959. Born, Winterthur, Switzerland, July 11, 1879. Education, BS(ME), Swiss Federal Institute of Technology, 1903; Dr. tech.sc.h.c., 1938. Mem. ASME, 1953. Dr. Buchi who celebrated his 80th birthday in July, 1959, was at that time still active in managing his engineering firm. He had earned an international reputation for his innovations in the field of turbocharging of oil and gas engines. Dr. Buchi's early career was as designer of diesel, gas, and steam engines at the S. A. des Ateliers Carel Freres, Ghent, Belgium. He then went to Honegger Co., Wetzikon, Switzerland, and was chief of research for diesel engines with Sulzer Bros. In 1927 he began the organization of the Buchi Syndicate for the development of turbocharging systems. From 1928 to 1935 he also acted as managing director of the Swiss Locomotive and Machine Works. The "Buchi system" for supercharging has had extended application in the stationary, the marine, and locomotive fields. From 1939 to 1943 Dr. Buchi was also a member of the Swiss Parliament. He was a Swiss delegate to the World Power Conference. Dr. Buchi was honored on many occasions and in the U. S., in particular, he was the recipient of the ASME Melville Medal Award in 1937 and The Franklin Institute George R. Henderson Medal in 1952. His papers were widely published, his works including 62 personal lectures. He held 43 U. S. patents. Those who survive him include a son, and a nephew, Prof. Dr. E. Dolden.

Abraham Beekman Cox (1874–1959), retired mechanical engineer and lawyer, Cherry Valley, N. Y., died Nov. 9, 1959. Born, Mount Holly, N. J., March 10, 1874. Parents, Abraham Beekman and Augusta McBlair (Ten Eyck) Cox. Education, AB, Yale College, 1895; attended Harvard and New York University Law Schools, and Columbia University Teachers College. Mem. ASME, 1914. Mr. Cox practiced law for a time and had been associated with a number of engineering firms. He obtained, in 1905, a patent on a compressed gas valve he invented, was coholder of a 1913 patent on a steam turbine, and held a 1919 patent on an artillery range finder and on a tractor. During World War I, he was commissioned a captain in the Army Ordnance Reserve Corps. In 1932 he was promoted to major. Mr. Cox retired, more than 25 years ago, to his farm where he supervised its dairy activities.

James Walter Dadley (1883–1959), design engineer, Pennsalt Chemicals, Chestnut Hill, Pa., died Nov. 4, 1959. Born, Paterson, N. J., March 3, 1883. Parents, Josiah and Elizabeth H. Dadley. Education, attended Northwestern Univ. Married Mildred Bock, 1915. Assoc. Mem. ASME, 1915; Mem. ASME, 1922. Mr. Dadley had been with the Pennsylvania salt manufacturing company since 1929. He was a registered professional engineer in the Commonwealth of Pennsylvania.

French Clinton Davis (1896–1959), vice-president, United Fuel Gas Co., Charleston, W. Va., died Oct. 17, 1959. Born, Spencer, W. Va., March 12, 1896. Education, received teacher's certificate, 1915. Mr. Davis had been with the Columbia Gas System since 1916. Mem. ASME, 1952. Mr. Davis was a registered professional engineer in the State of West Virginia.

Cherry Logan Emerson (1888–1959), retired vice-president, Georgia Institute of Technology, Atlanta, Ga., died Oct. 26, 1959. Born, Atlanta, Ga., June 9, 1888. Parents, William Henry and Lily (Cherry) Emerson. Education. BS(ME), Georgia Institute of Technology, 1908; BS(EE), 1909. Married Sina White, 1914. Mem. ASME, 1927. After five years as application engineer with Westinghouse Electric Corp., he joined the Duke Power Co., in the mill power department, afterwards becoming assistant to chief engineer, and serving in that capacity until 1919. From 1919 to 1945 he was connected with Robert and Company Associates, Atlanta, Ga. For three years he was president of that firm. In 1945 he became dean of engineering at Georgia Tech and vice-president in 1948. Mr. Emerson was a fellow of AIEE and a member also of ASCE; he was a past vice-president of NSPE.

Harold Vincent Farnsworth (1894–1959), vice-president, Haserick & Co., Inc., Framingham, Mass., died Aug. 15, 1959. Born, Revere, Mass., Oct. 5, 1894. Education, BTE, Lowell Technological Institute, 1916. Mem. ASME, 1955. Mr. Farnsworth had been with the textile-machinery firm since 1922. He was made a trustee and vice-president in 1942. During World War I, he served in the U. S. Navy. Mr. Farnsworth who was a specialist in the field of textile engineering, had published papers on the subject.

Albert James Gifford (1876–1959), formerly secretary-treasurer, Leland-Gifford Co., Worcester, Mass., died Jan. 18, 1959. Born, Worcester, Mass., June 4, 1876. Education, BS(ME), Worcester Polytechnic Institute, 1896. Assoc. Mem. ASME, 1903; Mem. ASME, 1931. Mr. Gifford was a past-president of the Worcester Engineering Society, a body formed through his constructive leadership. He was a trustee of the Worcester Polytechnic Institute.

William Huger Hardie (1904–1959), sales engineer, Riley Stoker Corp., Worcester, Mass., died Nov. 1, 1959. Born, New York, N. Y., Sept. 26, 1904. Education, BS, Sheffield Scientific School, Yale Univ., 1926. Married Jessie E. Hendrick. Mem. ASME, 1946. Mr. Hardie had previously been employed by the Foster Wheeler Corp. He held two patents. Survived by his widow; a son, William H., Jr.; and a daughter, Robin.

James William Hook (1884–1957), chairman of the board, The United Illuminating Co., New Haven, Conn., died Oct. 21, 1957, according to a notice only recently received by the Society. Born, Hedrick, Iowa, Jan. 9, 1884. Education, BME, Iowa State College, 1905. Married Hattie Rosamond Bechtel, 1907. Mem. ASME, 1935. Mr. Hook had been active in civic affairs; he had been a member of President Hoover's National Committee on Unemployment Relief, 1931–1933. He was the author of a number of articles published in MECHANICAL ENGINEERING and in *American Machinist*, on the subject of unemployment. He served the Society as a member of the Machine Shop Practice Committee, 1926–1927. Member also of AAAS.

Wilbur Gregory Hudson (1878–1959), consulting engineer, Chicago, Ill., died Oct. 22, 1959. Born, New York, N. Y. June 13, 1878. Parents, Wilbur F. and Amelia (Heybeck) Hudson. Education, ME, Cornell Univ., 1897. During World War I, Mr. Hudson was district supervisor for the North Atlantic District, Emergency Fleet Corp. He had also been vice-president and chief engineer, Curtiss-Wright Airports Corp.; and was chief engineer of the Link Belt Co., Chicago, Ill. Since retirement, he has been a consulting engineer specializing in the materials-handling field. He was the author of a book, "Conveyers and Related Equipment," and of many articles in the technical press. Mem. ASME, 1941.

Matthew Edwin Kennedy (1879–1959), chairman of the board and treasurer, The Kennedy Valve Manufacturing Co., Elmira, N. Y., died May 6, 1959. Born, Brooklyn, N. Y., Aug. 5, 1879. Parents, Daniel and Elizabeth (Moran) Kennedy. Education, high-school graduate. Assoc. Mem. ASME, 1906; Mem. ASME, 1930. Married 1913, wife deceased; three children, Mrs. Mary K. Kinkade, Mrs. Elizabeth K. Van Vliet, and Miss Florence M. Kennedy. Mr. Kennedy had been associated with the firm that bears his name since 1896.

William Clyde McCracken (1863–1959?), retired, chief engineer and superintendent of buildings and grounds, The Ohio State University, Columbus, Ohio, died recently according to notice received by the Society. Born, Lodi, Ohio; March 18, 1863. Education, attended high school. Mem. ASME, 1915. Mr. McCracken had been a specialist in the field of heating and ventilating.

Arthur Leonard Mullergren (1896–1959), consulting engineer, Kansas City, Mo., died Oct. 24, 1959. Born, Helena, Ark., April 15, 1896. Parents, Louis Peter and Rosa (Marshall) Mullergren. Education, high-school graduate. Married Christine Freeman, 1912. Mr. Mullergren was a specialist in the field of electric and gas utilities. He was a registered professional engineer in the states of Minnesota, Iowa, and Kansas. Mem. also ASCE and AIEE.

Henry Donald Mumper (1923–1959), engineering specialist, Combustion Engineering, Inc., New York, N. Y., died in an airplane crash at Buffalo, Texas, Sept. 29, 1959. Born, Heilwood, Pa., Oct. 24, 1923. Education, BS, Pennsylvania State University, 1943. Assoc. Mem. ASME, 1955. Mr. Mumper had been with Combustion Engineering since 1951. During World War II he served in the U. S. Marine Corps and during the Korean conflict he was recalled to active duty. Survived by his widow.

Malte R. Nederman (1903–1959), administrative engineer, international cigar machine division, American Machine and Foundry Co., Brooklyn, N. Y., died September, 1959. Born, Stockholm, Sweden, Oct. 18, 1903. Education, Columbia School of Drafting, three years. Junior ASME, 1925; Assoc. Mem. ASME, 1931; Mem. ASME, 1935. Mr. Nederman, a specialist in the field of automatic machinery, had been with AMF since 1926.

Knud E. Orno (1886–1959), manager of design section, Rayon Consultants, Inc., New York, N. Y., died Oct. 11, 1959. Born, Copenhagen, Denmark, Oct. 2, 1886. Parents, August N. and Augusta L. (Jacobsen) Petersen. Education, ME, Mittweida, Saxony, 1909. Naturalized U. S. citizen, 1918. Married Clio Aileen Conklin. Mem. ASME, 1927. Mr. Orno had previously been with the DuPont Rayon Co., Buffalo, N. Y. Survived by his widow.

Lester J. Richards (1893–1959), retired, director of engineering, The Dow Chemical Co., Midland, Mich., died Nov. 2, 1959. Born, Coopersville, Mich., Nov. 4, 1893. Education, BS(ME), Univ. of Michigan, 1917. Mem. ASME, 1952. Mr. Richards had been with Dow since 1917. Mr. Richards is survived by his widow, two daughters, and a son.

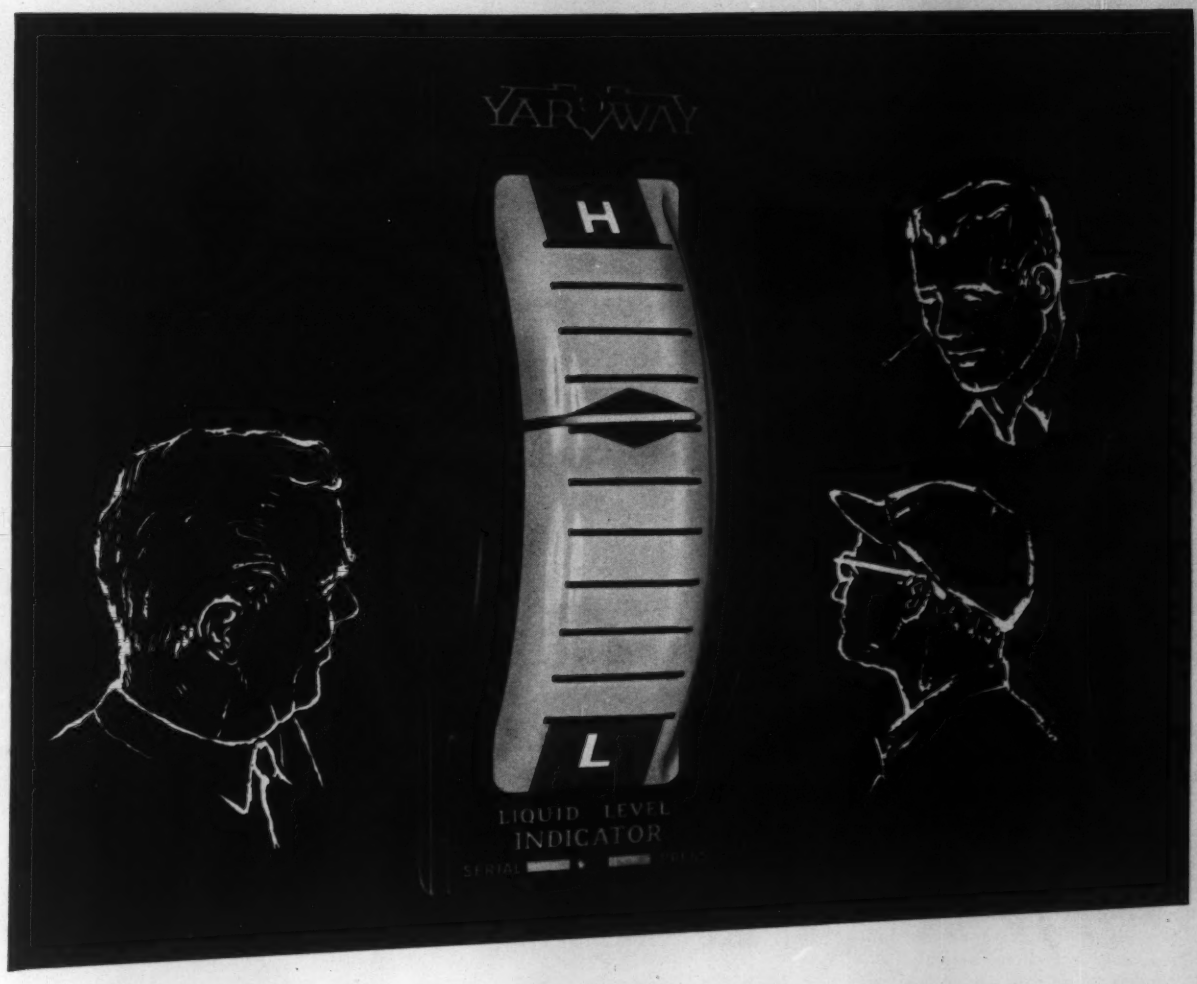
Robert Adam Schafer (1898–1959), vice-president in charge of engineering, Baker Bros., Inc., Toledo, Ohio, died Aug. 25, 1959. Born, Utica, N. Y., May 29, 1898. Parents, Adam John and Fredericka Schafer. Education, high-school graduate. Mem. ASME, 1943. Mr. Schafer had been with the tool-manufacturing firm for two years. Previously, he had been with the National Automatic Tool Co. for 31 years. A specialist in the field of hydraulic-control mechanisms and in drilling practice, he held 14 patents. Survived by his widow, Martha; two sons, F. Robert and William J.; two daughters, Mrs. Suzanne Tibbot, and Mrs. Marguerite Cobine; and a brother and two sisters.

Frederick Alden Spencer (1933–1959), junior test engineer, Wright Aeronautical Div., Curtiss-Wright Corp., Woodridge, N. J., died Oct. 7, 1959. Born, Braintree, Mass., Oct. 21, 1933. Education, BS(ME), Univ. of Massachusetts, 1955. Assoc. Mem. ASME, 1955. Survived by his widow, Janet M. Spenser.

Henry Clay Thompson, Jr., (1898–1959), associate professor of engineering drawing, Purdue Univ., West Lafayette, Ind., died Aug. 25, 1959. Born, Newport, Ky., Dec. 15, 1898. Education, BS(ME), Univ. of Kentucky, 1920; ME, 1937. Professor Thompson joined the faculty at Purdue in 1935. He was a registered professional engineer in the State of Indiana. Mem. ASME, 1949. Survived by his widow.

Francis du Pont Thomson (1860–1959?), retired, Elkton, Md., died Oct. 14, 1959. Born, Philadelphia, Pa., June 1, 1869. Education, BS(ME), Lehigh Univ., 1890. Assoc. Mem. ASME, 1892; Mem. ASME, 1899. Mr. Thomson's early career was with several heavy rolling-mill machinery manufacturers.

J. Laurence Waldron (1882–1959), retired, formerly with Brooklyn Edison Co., Inc., New York, N. Y., died Oct. 10, 1959. Born, Old Town, Maine, Dec. 11, 1882. Parents, James Winslow and Lauretta (Alford) Waldron. Education, AB, Columbia Univ., 1905; ME, 1907. Assoc. Mem. ASME, 1915; Mem. ASME, 1935. Mr. Waldron was a specialist in power-plant technology. He was a member also of AAAS and the American Statistical Association. Survived by his brother, Arthur M. Waldron.



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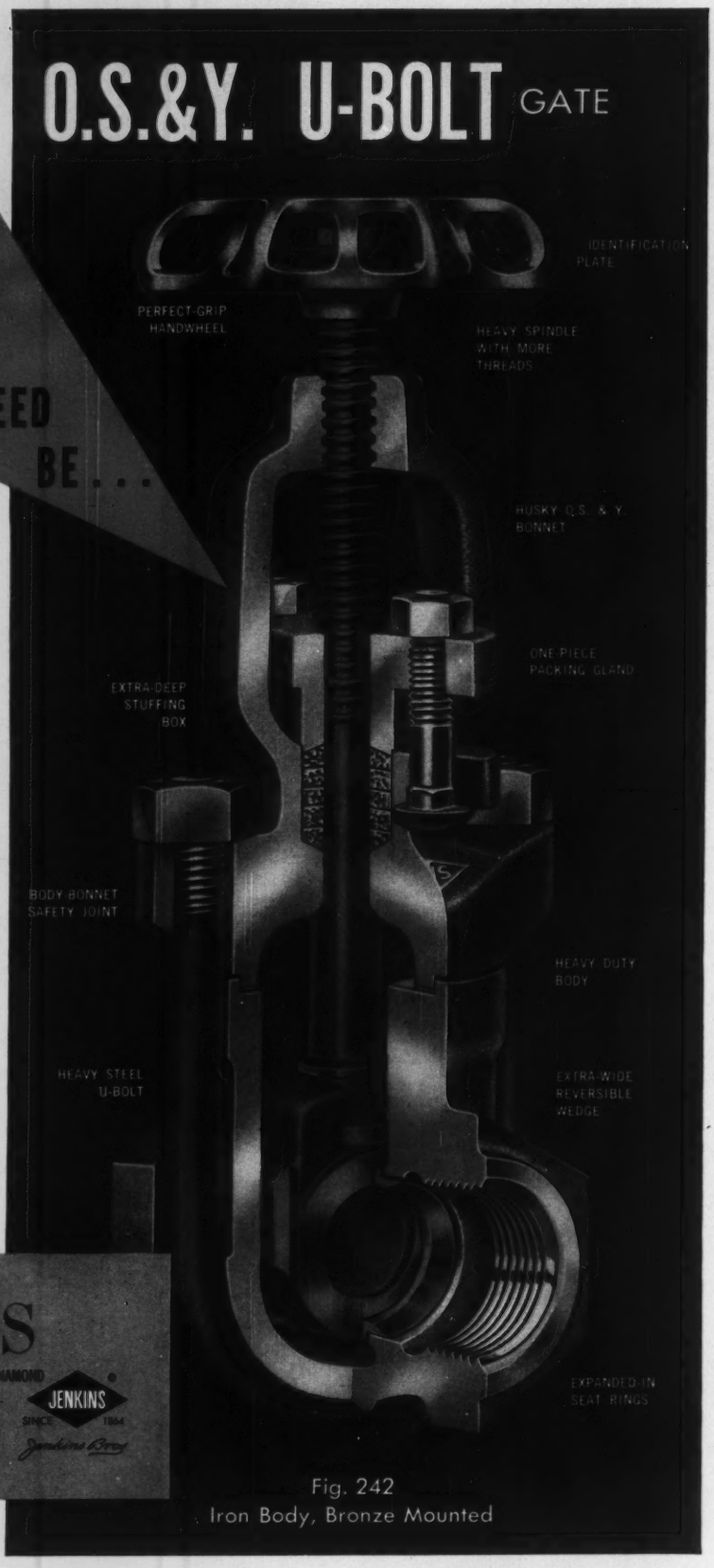

Fig. 242
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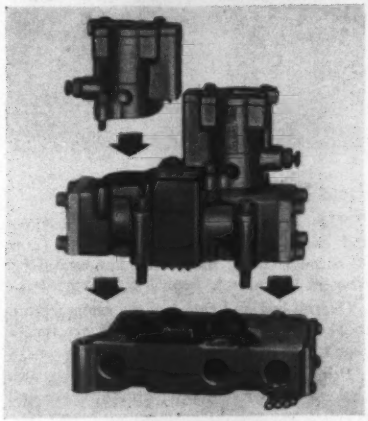


Pilot Control Valves

A new line of Speed King basic 1/2 in. single and double solenoid plug-in type pilot-operated 4-way control valves, featuring fast, automatic completion of electrical and pneumatic circuits, is announced by Valvair Corp.

Incorporating new one-piece solenoid pilot housings, plus aluminum bodies and sub-bases, the new valves are said to reduce maintenance time. All power connections, made permanently in manifold or sub-base, need not be disturbed for in-service maintenance, the firm reports. Electrical and pneumatic circuits to valve and pilot are completed automatically as the units are plugged in and bolted down.

The valves are said to provide extremely fast response, due to a new short-stroke design. Separate, coded 4-wire circuits on double solenoid models meet JIC requirements. Flow area through the valve and sub-base equals that of full 1/2 in. pipe.

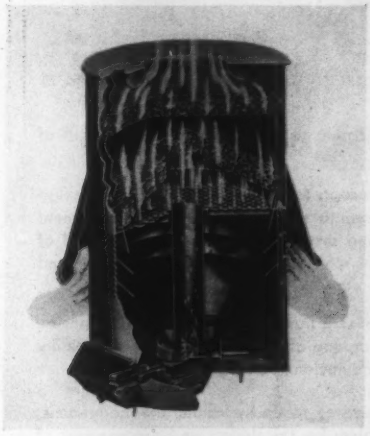
The valves, designed for a range of 35-200 psi air service, are available with solenoid coils for ac or dc, any voltage or cycle. Integral junction box is standard. Options include manual over-ride for use during machine setup and sub-base connected external pilot supply. Separate exhaust ports are tapped 3/4 in. NPT, with 1/2 or 3/4 in. NPT inlet and cylinder ports. Ask for Bulletin SPL. —K-1

Blowdown Mute

A silencer for quieting the discharge of steam, gas, and air exhausts, called the Pulso blowdown mute, has been introduced by Pulsation Controls Corp.

According to the company, the device serves also to collect and separate condensate, if any, and focus expended energy upward and away from the immediate environment. Test data proves the overall sound pressure level is reduced to approximately 80/86 decibels at 100 feet.

Capacities range from 1500 to 500,000 cf od air, gas, oxygen, and hydrogen and from 3000 to 1,000,000 lb-hr of steam condensables. Temperatures are from ambient to 1200 F. —K-2



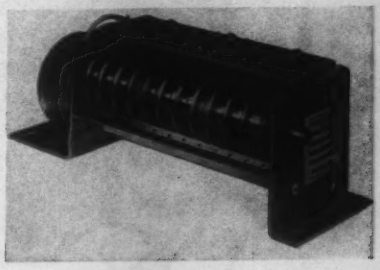
Oil Bath Cleaner

An oil bath air filter with a pneumatic oil lift and no moving parts has been introduced by American Air Filter Co.

The firm says the major improvement in the Model C Cycoil is the pneumatic lift, a simplified method of lifting oil from the reservoir to the perforated oil distribution plate, which in turn distributes the oil to the pads.

This replaces the motor-driven oil circulator used in previous models and eliminates the need for provision for electrical power with its complications of voltage rating, phase designation, and special protection for hazardous locations.

Other changes in the unit include a new cleanout door, the addition of a bullseye gage to observe and help control the oil level in the unit, and elimination of studs sticking out of the top of the unit. —K-3

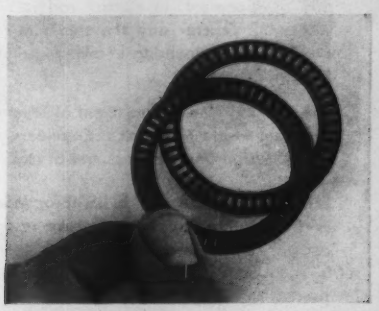


Program Timer

Eagle Signal Co. has announced a new repeat cycle timer measuring $2^1/_4 \times 2^1/_4 \times 7$ in., and containing 12 spdt independently adjustable and removable load switches.

Motor of the unit, designated HYS, operates on 115v, 60 cycle power. Time cycle is 90 sec.

Built for ground support equipment, the timer will withstand vibration of 0.060 in. double amplitude displacement from 5 to 55 cps and shock of 30 G's for 11 ms. The firm says the units extra large cams, $1^1/_8$ in. od, allow time settings with an accuracy of 1 per cent or better. —K-4

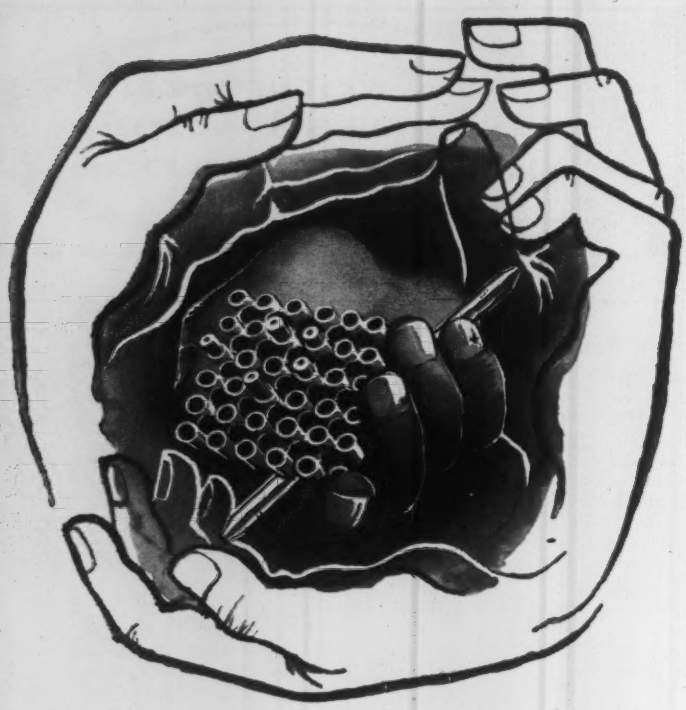


Bearing Cages

Glass-filled nylon cages for thrust bearings have been announced by Garlock Packing Co.

The company says that use of glass-filled nylon allows tramp metal invading the bearing area to imbed itself into the plastic. This imbedment removes ordinarily loose metal particles from circulation, greatly reducing bearing abrasion and consequent wear of adjoining metal surfaces. If the bearing cage should fail, the problem of metal particle entrainment is obviated.

Molded-in retention cavities firmly position and hold round or shaped bearings, which are simply popped into the receptacles. The material is said to have excellent wear resistance, and in itself requires no lubrication. —K-5



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ASSOCIATE ENGINEER with one to three years experience and a BSME or MSME degree. Will assist in the mechanical design and analysis of reactor core components such as fuel assemblies, control rods and core support structures.

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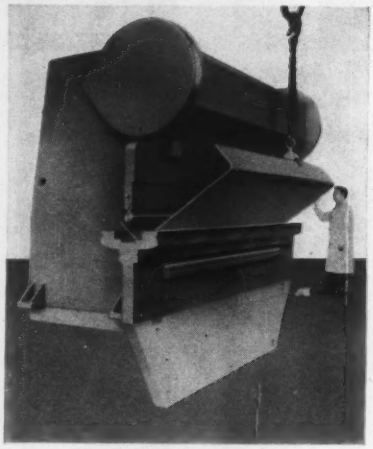

Press Brake Redesigned

New Series N press brake design features and expansion of tonnage capacities (now 90 through 1500) have been announced by Niagara Machine & Tool Wks.

Overall bed and ram lengths range from 6 to 24 ft, while bending capacities are for 12 gage to 1 in. mild steel.

Principal among the design changes are: choice of power or manual clutch, brake and treadle; two-speed transmission; rocker type end guide bearings for precise, endwise alignment, even when the ram is tilted for taper work; wide choice of special features and arrangements to meet individual conditions.

Construction is of one-piece welded steel except in the larger sizes where the deep bed, extending below the floor, is removable. Both frame and bed are scientifically designed for utmost rigidity and longer die life, according to the firm. A box type crown encloses connections and places them closer together for a stiffer ram. The latter, of extra heavy rolled steel plate, gives maximum support to dies, the manufacturer states.

—K–6

Lever-Type Grease Gun

A new lever-type grease gun that provides either high pressure or volume delivery of lubricant by means of a simple shifting device has been developed by Lincoln Engineering Co.

To change pressure ratios it is necessary to shift a latch pin in the handle from one slot to another. The manufacturer states that pressures up to 10,000 psi can be achieved in the high pressure position, and full pressure can be obtained with a stroke length as small as 1/4 in.

The gun incorporates a unique nozzle extension that swivels 360 deg. Write for Bulletin No. 230. —K–7

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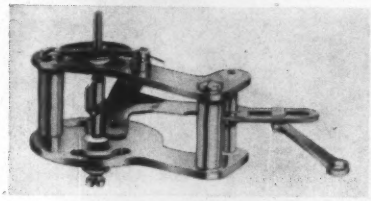


Pressure Instrument

A pressure instrument designed for high precision and enduring accuracy, has been introduced by Helicoid Gage Div., American Chain & Cable Co., Inc.

According to the firm, the units employ a time-tested movement—of simple cam and roller design—that does not have any teeth to wear out. The movement has been fitted with rigidized Teflon bushings, designed to provide low static and kinetic friction. The rigidizing component is added to promote compressive strength and increase resistance to cold flow. —K–8

Intermediate Paper

A new non-reproducible blue line intermediate paper has been developed by Ozalid Div., General Aniline and Film Corp.

Called Transblue 200T, it is a translucent, dry-developed diazo paper coated with a light blue line sensitization which is not reproducible on other diazotype materials.

The firm says the blue line serves only as a legible guide for the designer and does not obstruct actinic light and therefore will not reproduce. Any opaque image or line subsequently drawn in over the blue line will reproduce. —K–9

Spherical Roller Bearings

Hoover Ball and Bearing Co. has announced the addition of spherical roller bearings to its line.

The company states that the raceways and rollers that are finished to afford working surfaces of exceptional, mirror-like smoothness, which makes possible longer bearing life and superior performance.

The bearings are designed with a double row of large-size rollers to accommodate excessively heavy radial and shock loads. High contact angle provides for substantial thrust capacity in either direction, the firm says.

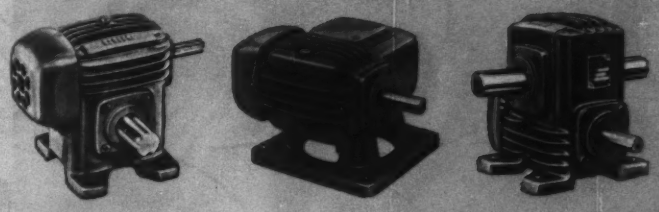
The bearings utilize a single spherical outer raceway to permit the bearing to compensate automatically for shaft misalignment in any direction, either initially or dynamically under load. Accurate roller guidance is provided by a heavy center guide flange between the two inner raceways, asymmetric roller design and heavy machined-bronze, land-riding retainers. —K–10

OHIO
SPEED REDUCERS & STOCK GEARS

A complete line available from local stocks everywhere

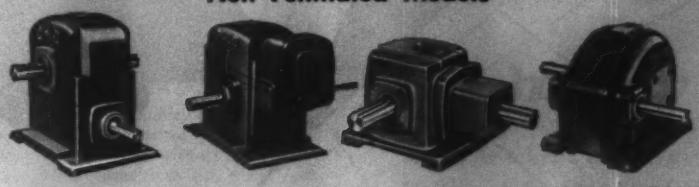
NEW OHIO LINE

These fin and fan cooled reducers give up to 80% more capacity in far less space. Over 100 models from 1/16 to 18 horsepower. Available with "C" flange motor mounts.

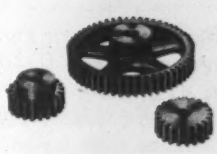


U Series P Series S Series

Non-Ventilated Models



Single Worm Double Worm Bevel Gear Helical Gear



Spur Gears

Worm Gearing

Miter Gears

Helical Gears

Fibre Gears

Bevel Gears

Local Stocks In 50 Cities
Gears & speed reducers available for immediate delivery ... see Yellow pages for name of your local distributor.

Free Catalog
Provides complete dimensions and engineering data on hundreds of off-the shelf items.

Ohio also supplies "special" gears and speed reducers

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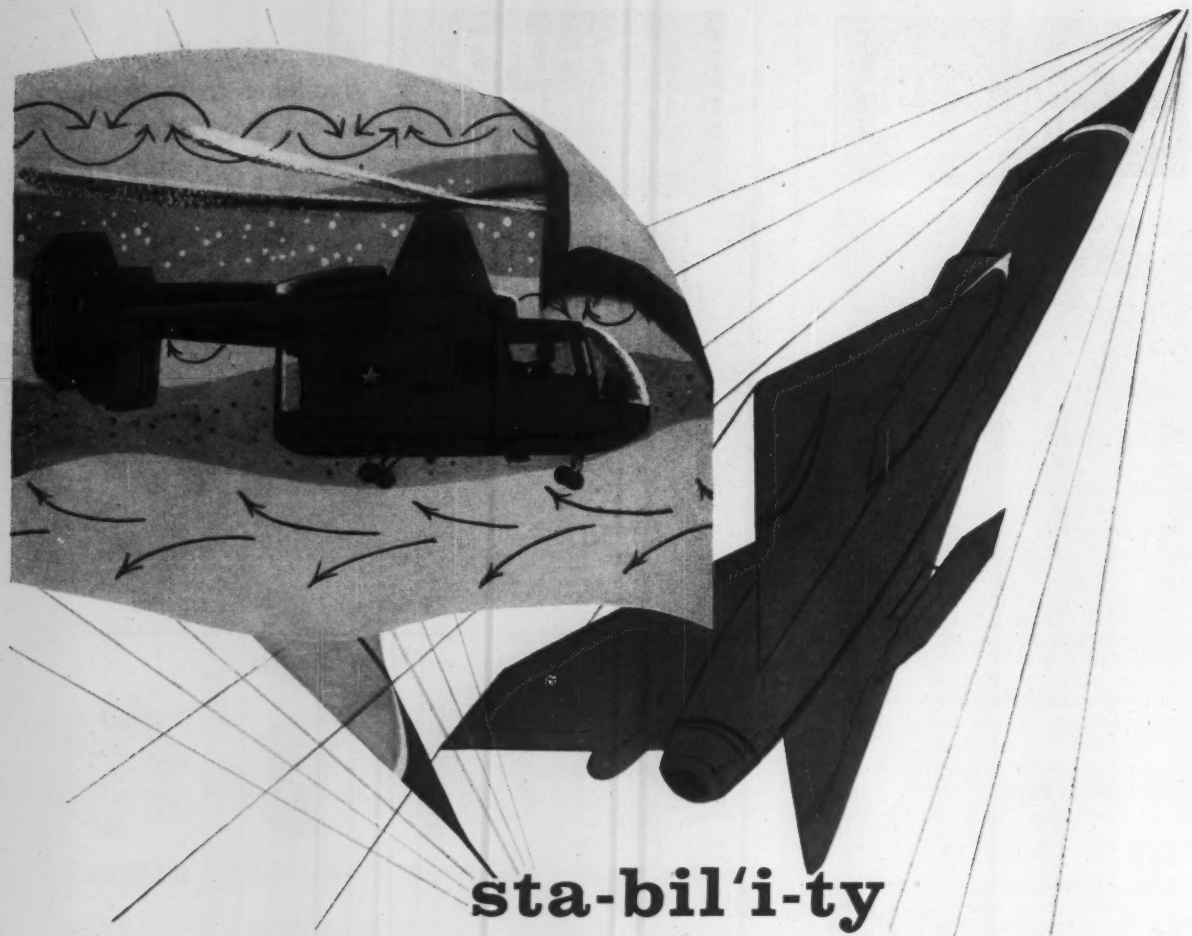

sta-bil'i-ty

World's Record #1

Bloomfield, Conn. — Air Force established new world record by flying Kaman H43-B turbine helicopter to 30,100 ft.

World's Record #2

Edwards AFB, Calif. — Air Force established new world record by flying Convair F-106 over an 18 km course twice, averaging 1,525.9 mph.

Stability augmentation from American-Standard steadies both of these record-setting vehicles. And in missiles — the Navy Terrier and Tartar; and submarines — the Polaris class, American-Standard, Military Products Division supplies gyros fundamental to accurate positioning and control.*

Company sponsored development in the Military Products Division has produced a family of gyroscopes, accelerometers and miniature components whose quality, performance and reliability make them unique in the field of navigation and stabilization systems.

Opportunities for Engineers

Winning this degree of acceptance has created new career opportunities in advanced design, production and applications engineering. American-Standard, Military Products Division, Norwood, Massachusetts.

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
MILITARY PRODUCTS DIVISION

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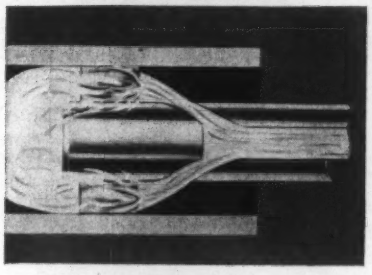

Liquid-Cooled Bars

A new line of liquid-cooled bars for adjustable boring and reaming cutters has been announced by Muskegon Tool Industries, Inc.

Designated polar bars, the new tool holders feature built-in veins which deliver streams of coolant directly to each of the two cutting edges, flushing away chips and preventing heat build-up.

The bars are available with straight or Morse taper shanks in a full range of sizes for all the firm's boring cutters and reamer blades, or for any other adjustable cutting tools of similar design. —K–11

Aluminum Fittings

Addition of aluminum and other alloys to its line of light wall Pipe-Mate fittings and flanges is announced by Tube Turns Div., Chemetron Corp.

Fittings of Type 6063T6 high strength aluminum alloy will be available in $\frac{1}{2}$ to 4 in. pipe sizes, Schedule 10S. Other aluminum alloys are also available, as are nickel, Monel, copper-nickel, and most other weldable alloys.

The company said that light wall aluminum fittings have many potential applications in chemical processing, petroleum, air conditioning, transportation, machinery, shipbuilding, construction, fertilizer, and other industries.

Cited particularly were advantages of light weight, corrosion-resistant piping in tank cars, trailers and marine tankers, original equipment and temporary installations where case of assembly and dismantling, low cost and long life and resistance to outside exposure would be of special benefit. —K–12

Needle Bearings

Kaydon Engineering Corp. has expanded its line to include 14 sizes of "off-the-shelf" needle bearings from $\frac{3}{8}$ to $1\frac{3}{8}$ in. in bore, described in Bulletin S-103

The firm says the key feature of these thin-shell bearings is the use of spherical-end needle rollers. The rollers permit the bearings to have up to 90 per cent more capacity and up to 6.85 times more bearing life than comparable bearings with conical-end rollers, the company states. This is designed to allow the use of smaller bearings for a given load requirement. —K–13

High Frequency Grinding

A high frequency spindle providing speeds up to 100,000 rpm is now offered on its standard Model 84 internal grinder by Rivett Lathe & Grinder, Inc.

The use of the spindle was developed in cooperation with the Allentown Works of Western Electric for grinding small holes with tolerances of ±.0004 in.

The 100,000 rpm spindles are powered by a high frequency electrical wheelhead and are mounted on the bed with an extra heavy bracket. Hole sizes from less than $\frac{1}{8}$-in. diam up to 3 in. may be ground to a micro inch finish. The spindles have oil mist lubrication and is water cooled.

They are supplied with arbor chucks, and are suitable for holding carbide burrs or mounted grinding wheels. —K–14

Switch-Maker's Kit

A special switch-making kit is announced by Detroit Controls Div., American-Standard for use by designers in developing switch combinations for special applications.

Containing the company's miniature snap action TyniSwitches, the kit is said to be the first to be offered designers to aid them in their development problems.

Thirty-two single pole, double throw switches available in the kit provide a representative assortment of Class 2 and Class 4 switches which may be used to simulate a multitude of combinations and also to build multipole switches. The switches are available in single throw, normally open or single throw, normally closed models. —K–15

sta-bil'i-ty

A note for talented engineers:

Stability at American-Standard is the result of dynamic action and can mean a lot in terms of professional growth at the expanding Military Products Division.*

The logical growth from the projects already in the house extends a tremendous challenge. And, the "off-site" advantages are as stimulating as the in-plant creative environment.

To repeat them just for the record: Residential Boston suburb, excellent benefits, relocation assistance, company-sponsored education, and the wide cultural and recreational attractions of the area.

Footnote: Excellent salaries for qualified engineers in both our Systems and Components Departments.

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American-Standard
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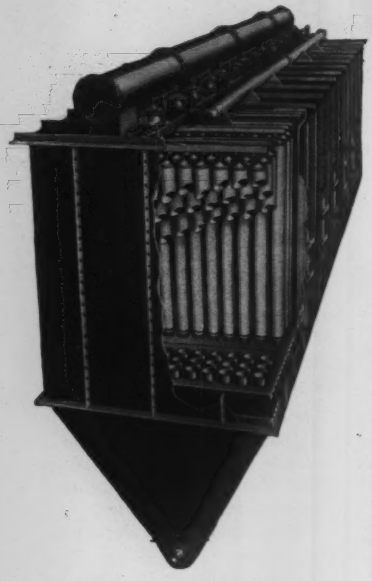
BUELL-NORBLO
TWO GREAT OLD NAMES IN ONE
GREAT NEW LINE

Full dust collecting capacity always available from

Norblo



Automatic Bag Type Dust Arresters

Twenty-four hours a day is a grueling grind, but Norblo equipment takes it. What's important to plant owners and operating staff is that full dust collecting efficiency holds level during the day and night punishment.

Norblo installations include a group of basic units, each housing 78 cylindrical bags. Variable cyclic cleaning involves one compartment at a time, and that for only a few seconds. Engineered to the needs of each installation, there's ample capacity without waste, but without undue strain on the equipment. Easy maintenance is provided for.

Whether your need is for a moderate amount of dust or fume collection or a large scale operation, a Norblo System gives you efficient performance at economical cost. Write for information; state your collection problem.

With the acquisition of The Northern Blower Company, Buell can provide a broad range of products and systems for handling every industrial dust and air pollution problem. Norblo bag type collectors now augment Buell Cyclones and other mechanical collectors, electric precipitators, combination systems and centrifugal and gravitational dust classifying systems. And like Buell, Norblo has been accepted and proved through years of experience in active, on-the-job service. Thus Buell continues to meet both standard and special requirements in fields that include the electric utilities, steel, oil, cement, chemical, paper, and other process industries.

Buell Engineering Company, Inc.
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Copying Machine

An automatic, high-speed copying machine, which can be teamed with a collator that assembles copied materials in their correct sequence, has been introduced by Charles Bruning Co.

The diazo copying machine, Copyflex Model 60, was designed for high volume production of letter-size copies. The company says it smoothly integrates printing, cutting, and stacked delivery of any desired number of copies in one continuous mechanical operation.

When the operator sets an indicator to the number of copies desired, the machine prints and cuts them to an $8\frac{1}{2} \times 11$ letter size from a roll of sensitized paper. After the required numbers have been copied, the original is ejected and the next original automatically inserted for any pre-set quantity of copies.

—K-16

Servo Motor-Brake

Western Gear Corp., Electro Products Div., announces the design and manufacture of a new servo motor brake combination.

Engineering specifications include stall torque motor alone .48 oz-in.; brake range available .03-.1, ± .01 oz-in.; size 1 in. diam × 1.85 in. long; designed to meet MIL-E-5272; 115 v, 400 cycle, both phases; nominal impedance 1450 plus JI600. The brake does not change linearity of the speed torque characteristic, the firm reports. The unit has a stainless housing, end bells and shaft, and can be produced with size 10, size 11, or 1 in. mounting.

A design including an integrally mounted gear box with ratios up to 8000-1 is available. The company says the gear box will add approximately 1 in. to the overall length of the unit.

—K-17

Metering Pumps

Wallace & Tiernan Inc., has announced production of a new metering pump line, Series 200.

The pump is electrically driven and is of the positive displacement, reciprocating, plunger type. It has a range of capacities from 0.65 to 2025 gph. With a metering accuracy within ±1 per cent the standard model operates against pressures up to 4000 psi. All parts that may come in contact with corrosive solutions are made of corrosion-resistant materials, the firm reports.

The pump drive was designed to function with one, two, or three liquid ends. The firm says the liquid ends can be changed as complete units for different capacities or liquids. A number of simplex, duplex, or triplex units may be coupled to the same drive shaft for blending two or more liquids.

—K-18

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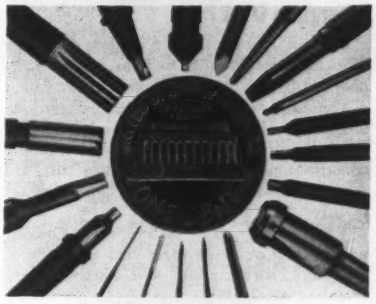
NEW EQUIPMENT
LATEST CATALOGS



Miniature Cutting Tools

Waltham Precision Instrument Co. has established a Small Tools Div. for the marketing of its line of micro-miniature cutting tools.

The line of taps go down in size to .012 in. diameter with 338 threads per inch. Among the other tools in the line are spotters, drills reamers, broaches, countersinks, counterbores, dies, hollow end mills, face mills, lip mills, routing cutters, keyway cutters, fly cutters, poising and circular saws. —K–19

Shock Testing Machine

Barry Controls Inc., announces development of its 16750 Varipulse shock machine, specifically designed for production and laboratory testing of small electronic, electromechanical, and mechanical components.

The unit accommodates test specimens weighing up to 20 lb and occupying an 8-in. cube. It is designed to provide accurate and repeatable half-sine, saw-tooth, and square waves.

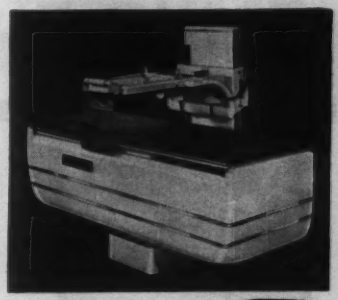
The company says the same pulse is reproducible in test after test and from one machine to another. The unit utilizes the gravity free-fall principle, and a remote push-button control and a disconnect interlock provide safety features for the operator.

—K–20

V TOWARD GREATER VICTORIES

JOIN THE MARCH OF DIMES

Winsmith speed reducers specified for Westinghouse Fluoradex X-ray tables . . .



Fluoradex "150" Radiographic-Fluoroscopic Table. Horizontal position.

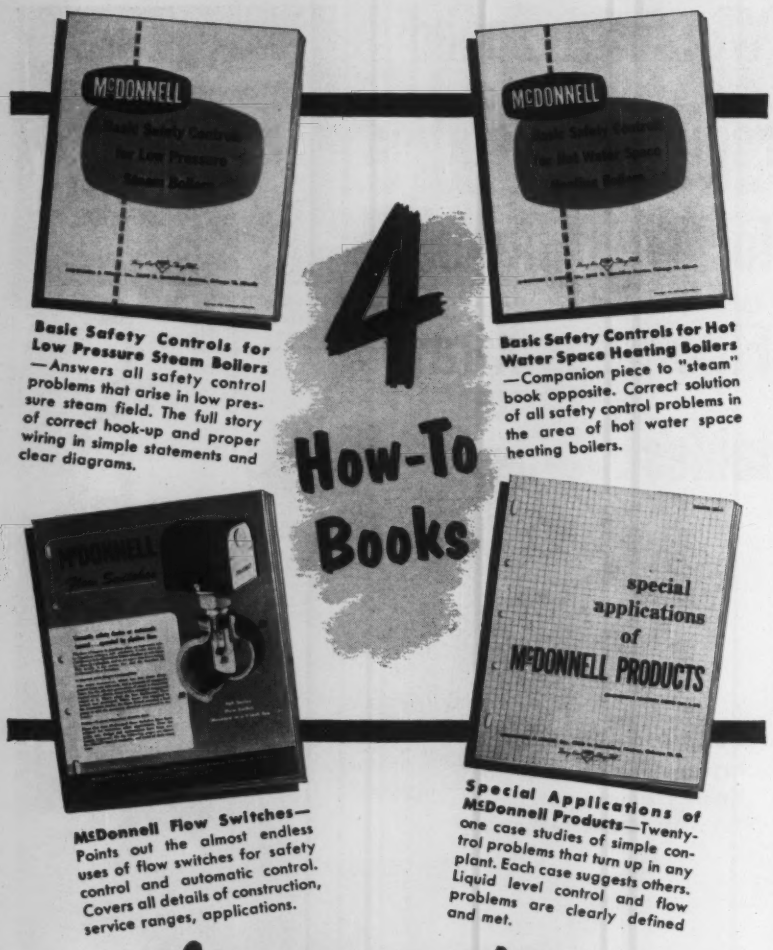
TABLE BASE, REAR VIEW
Table is tilted by precision linkage mounted on a multiple sprocket, chain-driven through a compact Winsmith Differential Reducer.

Fluoradex Radiographic-Fluoroscopic Tables are precision instruments of high strength and flexibility, combined with safe, quiet operation. For table tilt motion in keeping with this high-quality design, Westinghouse specified a Winsmith Differential Reducer with 108:1 reduction. Reasons for the Westinghouse choice of Winsmith—compact design, efficiency and quiet operation—are the same reasons so many other leading manufacturers also specify "Winsmith"... the most complete line of speed reducers from a single source of supply.

WINSMITH SPEED REDUCERS

WRITE TODAY for Catalog No. 155 for full details on selection, operation and maintenance of the hundreds of Winsmith types and sizes for every drive application.

WINSMITH, INC. 20 Eaton Street, Springville, (Erie County), N. Y.



Basic Safety Controls for Low Pressure Steam Boilers—Answers all safety control problems that arise in low pressure steam field. The full story of correct hook-up and proper wiring in simple statements and clear diagrams.

Basic Safety Controls for Hot Water Space Heating Boilers—Companion piece to "steam" book opposite. Correct solution of all safety control problems in the area of hot water space heating boilers.

McDonnell Flow Switches—Points out the almost endless uses of flow switches for safety control and automatic control. Covers all details of construction, service ranges, applications.

Special Applications of McDonnell Products—Twenty-one case studies of simple control problems that turn up in any plant. Each case suggests others. Liquid level control and flow problems are clearly defined and met.

—for every engineer

Here are four bulletins that can make a basic contribution to the things every operating man seeks...more efficient operation... automatic operation...safer operation.

Read the brief descriptions of these booklets. *Use the coupon to request any or all of them.*

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Send me a copy of bulletin(s) checked:

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Mail to: McDonnell & Miller, Inc., 3510 N. Spaulding Ave., Chicago 18, Ill.

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Fiberglass Duct Fans

Expansion of its line of fiberglass duct fans to include sizes from 12 to 36 in. has been announced by the Hartzell Propeller Fan Co.

The fans, which under many conditions are said to offer resistance to corrosion equal to or exceeding that of stainless steel or monel construction at substantially lower cost, are now available in 12, 16, 20, 24, 28, and 36 in. diam.

The propeller, duct section, drive housing and bearing cover on these fans are made of fiberglass; drive shaft and hardware are stainless steel. —K-21

Recorder-Controller

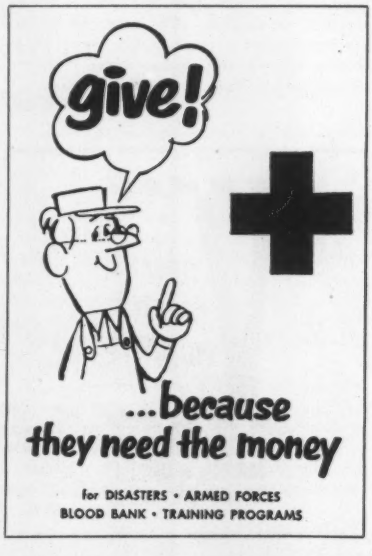
A new round chart recorder said to feature accuracies of $\pm 1/4$ per cent is now available from General Electric, Instrument Dept.

The company says most of the recorder's components are interchangeable with those of existing G-E strip-chart models. Minimum accurate scale span for the recorder, a null-balance, potentiometer-type design, is one mv d-c. Response times available are 4, 10, and 24 sec full scale.

A zener diode, which eliminates use of a dry cell or standard cell power supply, offers a constant voltage reference accurate to ± 0.05 per cent. Temperature coefficient is 0.001 per cent per degree Centigrade.

The control portion of the recorder features trip switch cams that are individually adjustable. Advantage of this design, the company says, is that a single cam can be reset without upsetting the others.

Concentric scale length is 27.5 in. Single- and two-pen models are available, with pen speeds of 4, 10, and 24 sec full scale. Chart speeds are 1, 8, 12, or 24 hr; or 7 days. —K-22



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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Buffing Machine

A new oscillating arm-type machine designed to provide a method for automatically buffing or polishing parts which have obstructions that prevent complete rotation is now available from Acme Mfg. Co.

Basically, the machine consists of an Acme E-10 semi-automatic machine equipped with an air cylinder advance and an oscillating arm fixture. Parts can be mounted on an arbor with a locator and square drive. Then the arbor and part assembly are positioned in the oscillating-arm unit by an air-powered tailstock.

Other special types of part chucking arrangements can be provided to suit the part requirements. —K–23

Lathe Tracer

A 90-deg tracer designed specifically for use on its heavy duty and standard duty lathes has been announced by the R. K. LeBlond Machine Tool Co.

It will trace from either flat or full round templates, the firm says, and is designed for tracer-turning stepped shafts, spindles, gear blanks, forming rolls, arbors, axles, cones, sheaves, pistons and balls.

A master workpiece can be used for a template, or a flat template can be cut from flat stock. The template is mounted between centers behind the workpiece, and the tracing stylus contacts it from below. When the tracer is operating, the cross-slide screw is locked out (so it can't wear) and motion is transmitted directly fron the tracer cylinder to tool turret by a solid steel bar. Hydraulic elements and hoses are rear-mounted. —K–24

Aluminum Finned Resistors

A 50 per cent reduction in size, achieved by encapsulating power resistors in an anodized aluminum case provided with fins, is claimed for a new line of 25 and 50 w units manufactured by Pacific Resistor and Cable Co.

Heat dissipation is provided by mounting the resistor casing flat against the chassis as well as by the cooling fins. The resistors are said to be self-supporting, and do not require lugs or mounting brackets.

The CH25 series is rated at 25 w at 25 C ambient and is offered in a resistance range of from .1 ohm to 16 K ohms. The CH50 series is rated at 50 w at 25 C ambient and is offered in a resistance range of from .3 ohms to 175 K ohms.

Both series derate to 0 per cent of rated power at 275 C ambient. Standard tolerance is 1 per cent. Temperature coefficient is 20 parts per million per degree C. Dimensions, exclusive of mounting flanges and terminal lugs, are $^{9}/_{16} \times {}^{5}/_{8}$ in. for all models; length of $1^{1}/_{16}$ in. on the CH25 units, $1^{29}/_{32}$ in. on the CH50 models. —K–25

THE PUMP THAT SEALS ITSELF

JOHNSTON "LIQUI-SEAL" UNIT LINE ends packing box or mechanical seal failures forever.

How "Liqui-Seal" seals itself

Here's a pump that seals itself by hydraulic action, thus putting an end forever to leaking packing boxes and mechanical seals.

PUMPS ALL LIQUIDS INCLUDING:

Gasoline; Jet Fuel; Corrosive Liquids; Kerosene; Light Oils; Salt Water

PRINCIPAL APPLICATIONS:

Raw water supply
Transfer Pumps
Gasoline Fueling
Waste Water Disposal
Bonderita Systems
Water Wash Paint Spray Booths
Mill Scale Sumps
Cooling Towers
Dry Dock and Marine Dewatering
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Bulk Loading Pumps

OTHER ADVANTAGES:

Pump is always primed
Takes minimum floor space
Mounts easily on ASA Standard flanges or on sump covers
Lubricated by fluid being pumped, thus eliminating any possibility of contamination

For complete details contact your nearest Johnston Distributor or write direct to the factory for colorful bulletin.

JOHNSTON PUMP COMPANY

A DIVISION OF THE YOUNGSTOWN SHEET AND TUBE COMPANY

3272 E. Foothill Blvd., Pasadena, Calif.

IF THERE'S A DUST HOG ON YOUR PAYROLL...

...let Pangborn Dust Control stop this waste!

Dust Hogs eat away profits! See for yourself—add up the cost of your lost salvageable material, housekeeping expenses, excess machine wear, intangibles such as community and employee goodwill. Whether your cost of feeding a Dust Hog is moderate or high, Pangborn Dust Control will cost you *less* than you are now paying for uncontrolled waste.

For details on Pangborn's engineering knowledge and experience, talk to the Pangborn man in your area or write PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment—Rotoblast® Steel Shot and Grit.* ™

Pangborn CONTROLS DUST

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Acceleration Switch

A miniature, unidirectional, single-axis switch capable of closing an electric circuit in response to a preset acceleration level and resetting itself when the acceleration drops below the preset value has been announced by W. L. Maxson Corp.

The unit consists of a gas damped seismic system with a range of 5 to 60 g, an accuracy of ±5 per ceet, repeatability of ±.25 g, a damping ratio of .8 of critical and a temperature range of −65 to +250F.

Switch is spst, normally open with contact rating of 100 ma. Unit is hermetically sealed, weighs 3/4 oz and has dimensions of $1^3/_{16} \times {}^7/_{16}$ in. od. **—K-26**

Shutoff Valve

A new miniature leakproof shutoff valve designed for use in vacuum or pressure service is now available from Circle Seal Products Co.

The valve features an O-ring on the cylindrical face of the straight plug which is designed to absolutely prevent leakage past the inlet port as well as the critical stem area. The T handle position instantly indicates exact valve position. A quarter turn is all that is required from full open to dead tight close.

The valve is available in brass or stainless 303 with either male or female connections in 1/8 or 1/4 in. size. **—K-27**

D-C Crane Control

Type PT crane control, introduced last year by EC&M Div., Square D Co., now features self-contained undervoltage and overload protection designed to provide full magnetic control on any d-c application up to 55 hp, 230 v.

The firm says the controllers are front-connected for mounting against walls or girders, fit easily in cabs, on crane walkways or wherever space is limited. An exclusive Wright dynamic lowering circuit used in control gives maximum hook speed without danger of overspeeding, the company states. Automatic acceleration relays are adjustable from 0.2 second or more per step.

The control is also supplied without protection for use with separate protective panel. It is available in NEMA Type 1 general purpose, Type 1 gasketed, or NEMA Type 3 enclosures. **—K-28**

Use a CLASSIFIED ADVERTISEMENT *for Quick Results*

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Motor Relay

A new relay, Type COM-5, designed for complete motor protection from very light to heavy overloads is now available from Westinghouse Electric Corp.

According to the company, the relay provides protection by combining several elements to more closely match the motor heating curve. From minimum pickup to 175 per cent of tap value setting, an alarm is sounded and an operator is allowed five to ten minutes to remove the trouble.

With medium overloads, the COM-5 gives normal time delay tripping protection. The relay provides for instantaneous tripping on heavy fault current. —K–29

Power Cylinders

Hanna Engineering Works has announced its new Powrmation series low pressure air and hydraulic cylinder line in 1 $^1/_2$ through 8 in. bores and with capacities of 250 psi air and 400 to 1000 psi hydraulic.

The company states that a variety of mountings, rod diameters, and rod ends make the cylinder adaptable to practically any installation. Mountings include side lug, center lug, basic, tie rod, flush side, front flange, rear flange, trunnion, clevis, and double rod styles. Strokes can be made to any practical length. An extra long bearing available with an optional gland makes internal spacers unnecessary in many long stroke cylinders, the firm reports. —K–30

Bracket Nut

A rugged new one-piece, self-locking right angle bracket nut has been developed by Elastic Stop Nut Corp. of America for use in attaching wire bundles and plumbing lines to missile and airframe structure.

The firm reports that extensive research and development in direct cooperation with the aircraft industry created the extra rigid one-piece LHA71 bracket nut as a replacement for a variety of attachment methods ranging from sheet metal brackets to direct bolting to structure.

The new design has been thoroughly tested and approved for push-out, twist-out, tensile strength, reuse, vibration and shock as well as application tests under unusual installation practices and conditions, the company states.

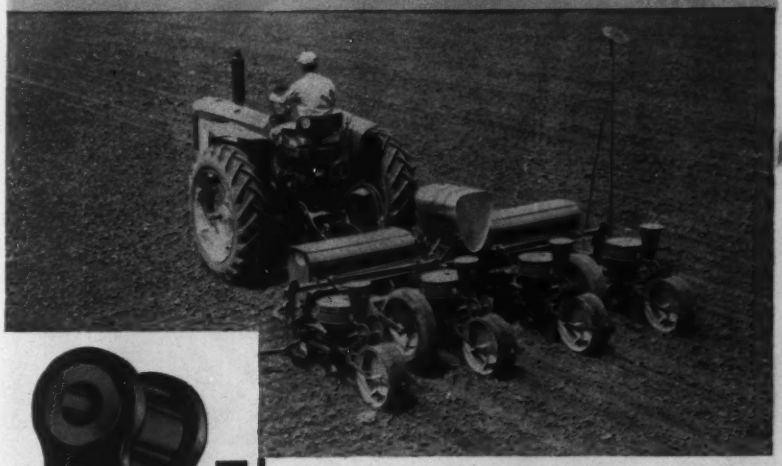
Made of cadmium plated carbon steel, heat treated, for performance at temperatures up to 550 F, the nut exceeds performance requirements of MIL-N-25027(ASG). The firm says mounting holes .130 in. diam permit the use of $^1/_8$ in. aluminum alloy rivets to develop full bracket strength.

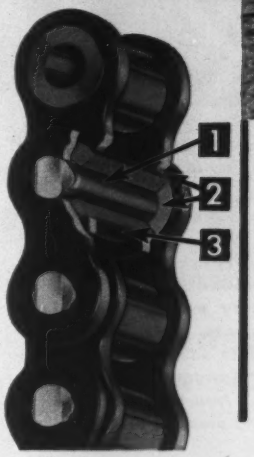
It is presently designed in the 10–32 thread size in three bracket lengths of .450, .650 and .850 to provide variations in clamp location. Parts may be had with or without molybdenum disulphide dry film lubricant. —K–31

John Deere

Found a Chain Drive That—

1. REQUIRES NO LUBRICATION
2. IS SELF-CLEANING
3. REQUIRES NO MAINTENANCE
4. OUTWEARS ORDINARY CHAIN





Critical Area 1:

PIN—Protective oil film lubricates live bearing area between pin and bushing, minimizing wear by reducing metal-to-metal contact.

Critical Area 2:

PLATES—Oil-impregnated Sintered Steel Bushings extend beyond surface of inside plates to: act as lubricated thrust bearings, control clearance, and provide an oil cushion between plates, eliminating plate galling and seizing frequently caused by misalignment of sprockets.

Critical Area 3:

SPROCKET ENGAGEMENT—Oil film on MSL Bushing exterior provides constant lubrication between sprocket teeth and chain. Whitney MSL Chain requires no rollers, as the tough oil film on the bushing surface provides smooth sprocket engagement, cushions impact and reduces drive wear.

Chain drives on farm machinery take a beating. Dust, dirt, corrosion and rust—inadequate lubrication, and hit-or-miss maintenance, all add up to "stiff joints"—the major cause of chain failure.

John Deere provides owners of its 494 and 495 Planters with extra insurance against drive chain trouble by using advanced design Whitney MSL* Self-Lubricating Chain on main drives of these machines. Because John Deere engineers recognized the advantages of MSL Chain's built-in lubrication at all 3 critical chain areas, farmers aren't bothered with the usual problems encountered in equipment drives. And they get longer chain life—up to 5 times longer—than that provided by conventional chain.

If the drive chain on your product must deliver top performance in severe operating environments, or operate with maximum cleanliness, Whitney MSL Chain can do the job. Standard and Extended Pitch MSL Chain conforms fully to ASA Standards, making it completely interchangeable with any similar pitch ASA standard chain. Write for MSL Chain Catalog today.

*Maximum Service Life

THE WHITNEY CHAIN COMPANY
a subsidiary of FOOTE BROS. GEAR AND MACHINE CORPORATION
4559 S. Western Blvd., Chicago 9, Ill.

POWER TRANSMISSION DRIVES

Chace Thermostatic Bimetal

ACTUATES ANOTHER PRECISION PRODUCT

THE

THERMOSTAT

A PRODUCT OF AMERICAN-STANDARD
DETROIT CONTROLS DIVISION, DETROIT, MICHIGAN

This new thermostat, No. CA 520, a product of American-Standard, Detroit Controls Division, offers the ultimate in style, comfort and dependability. It was designed and manufactured especially for use with American-Standard Furnaces, the "one responsibility" concept. Its features include: hermetically sealed mercury switch; soldered circuit joints and flexible wire; clear plastic base plate for fast installation; five-degree dial calibration and wider selection of temperatures (50° to 90°); and attractive decorator design with concave rim and cover, in bronze and silver, (or paint it yourself). Both the actuating element and the temperature indicating element are Chace Thermostatic Bimetal.

Perhaps sensitivity (or lack of it) is the one feature of a room thermostat most likely to impress the homeowner. One wants to be unconscious of a heating system, not reminded by frequent periods of chill or overheating. The extreme sensitivity and unfailing reliability of Chace Bimetal are the result of Chace's third-of-a-century devoted to the development of efficient alloys and bimetal combinations, plus manufacturing methods and equipment devoted exclusively to the production of precision thermostatic bimetal. Discriminating bimetal buyers can always be certain that their names on the "outside" are safe with Chace "inside."

Chace Thermostatic Bimetal is available in strips, coils and completely fabricated elements of customers' designs — and in more than 30 types. If you have a product in the "thinking stage," send for our booklet, "Successful Applications of Chace Thermostatic Bimetal," for its many pages of illustrated temperature-actuated devices plus much valuable engineering data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Temperature Controller

Edwin L. Wiegand Co. announces a new type PC Chromatrol electronic controller designed to give highly sensitive temperature control, within 1 deg. F, up to 600 F.

The stainless steel sensing element is a very small bullet-probe 1 in. long and 1/4 in. in diameter. The company says the pre-aged thermistor probe may be located in platens, in air ducts and in immersion wells up to 100 ft away from the amplifier-relay cabinet using inexpensive light-gage twisted lead wire.

Loads up to 10 kw can be controlled directly without a separate magnetic contactor, the firm reports. The unit may be used on 120, 208, or 240 v, 60 cycles. Scale covers dual-range from 25 to 225 F or 200 to 600 F. The dial-plate control is removable from the amplifier-relay for remote location up to 30 ft away. **—K–32**

Hydraulic Cylinders

Series H hydraulic cylinders are now available with straight thread ports as a standard, according to Power Cylinder Div., Hannifin Co.

The company says research has shown that the use of straight thread cylinder ports eliminates many of the leakage problems associated with pipe thread cylinder ports.

Other benefits claimed are no distortion due to the wedging action of a pipe thread connection; elimination of pipe dope; exact positioning of the fitting without overtightening or back-off; immunity to leakage caused by extreme temperature variance or shock conditions; and mechanically rigid connections since fittings work on the full thread surface. **—K–33**

Dust-Resistant Coating

A water-like fluid said to possess the unique property of making a smooth paint surface so slick that dust and dirt cannot cling to it has been successfully field tested for industrial maintenance by the Du Pont Finishes Div.

Secret of the new coating is that the microscopic pores of a seemingly already smooth surface are filled to produce a slickness so total that there is virtually nothing for dirt to adhere to, the firm reports.

Based on colloidal silica, the soil retardant concentrate is mixed one part with 14 parts water, and sprayed, brushed, roller-coated, mopped, or wiped on a clean interior or exterior painted surface as thinly as possible. The company says that within 15 minutes a hard, transparent coating has formed that sheds dust and dirt particles deposited from the atmosphere. **—K–34**

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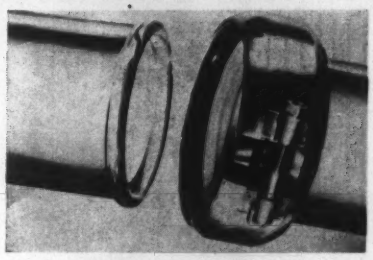


Glass Drainline

A new lightweight glass drainline system featuring simple, one-piece couplings for making quick, permanent compression joints has been introduced for disposal of chemical wastes by Corning Glass Wks.

The company says the system is designed for vertical or horizontal mounting. It can be buried in the ground. Trademarked Pyrex brand lifetime drainline, the product, is guaranteed against breakdown by corrosion or joint leakage for the lifetime of the building in which it has been installed.

The piping and fittings are made of hard, low expansion borosilicate glass that is resistant to virtually all corrosives. Only massive quantities of hydrofluoric acid and hot alkalies measurably affect the material, the company says.

The coupling consists of a stainless steel shell, a rubber sleeve, and a liner of Teflon 100-X, a material that is said to be as corrosion-resistant as the glass. —K-35

Shaft Collars

A line of noncorroding precision shaft collars made of cold-drawn stainless steel is announced by Climax Metal Products Co.

The collars are precision bored with chamfers machined on inside and outside corners, according to the company. Stainless steel socket cup-point set screws are used with the collar and are factory-assembled.

Thirty-one bore sizes available from stock range from $\frac{1}{8}$ to $2\frac{1}{8}$-in. diameter in $\frac{1}{16}$ in. increments. Collars are uniformly packed in standard quantities, depending upon size. —K-36

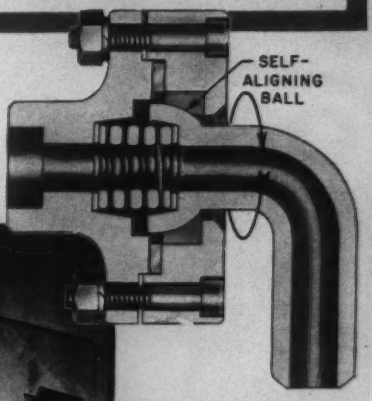
Electromagnetic Counter

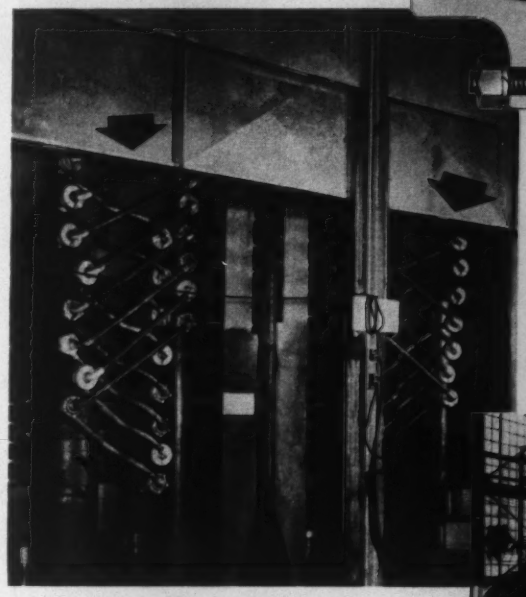
An electromagnetic counter displaying six digits in a case slightly more than 2 in. wide has been developed by Veeder-Root Inc.

The dimensions are 2.092 in. wide, 2.401 in. high, and 2.250 in. deep, including the four-hole mounting flange, or base. The wheels are white, die cast metal with black, .188 in. high characters. Operation may be on standard 115 v a-c or on other a-c or d-c voltages, on special order. Power consumption is approximately six watts. Maximum constant speed rating is 700 counts per minute. —K-37

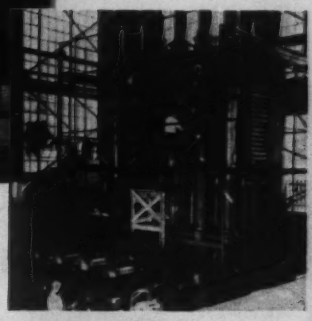
How to Handle 550 psi Steam —Use BARCO Series 850 Swivel Joints!

On Multiple Platen Hardboard Presses





Left—A close-up view of 1¼" Barco STWS Swivel Joints in new hardboard plant of Abitibi Corporation in Alpena, Michigan, on an R. D. Wood Company fifteen platen press. The joints handle 500-550 psi steam, 450°F, twenty-four hours a day.



HIGH PRESSURE STEAM SERVICE

The Barco "Series 850" Swivel Joint is a new development. It is *the key* to solving many PIPING FLEXIBILITY problems where high temperatures and pressures are encountered. Many of these joints are now being used to make flexible "Dog Leg" piping connections for steam supply and condensate drainage of movable platens on giant hardboard presses, as illustrated by the accompanying photographs.

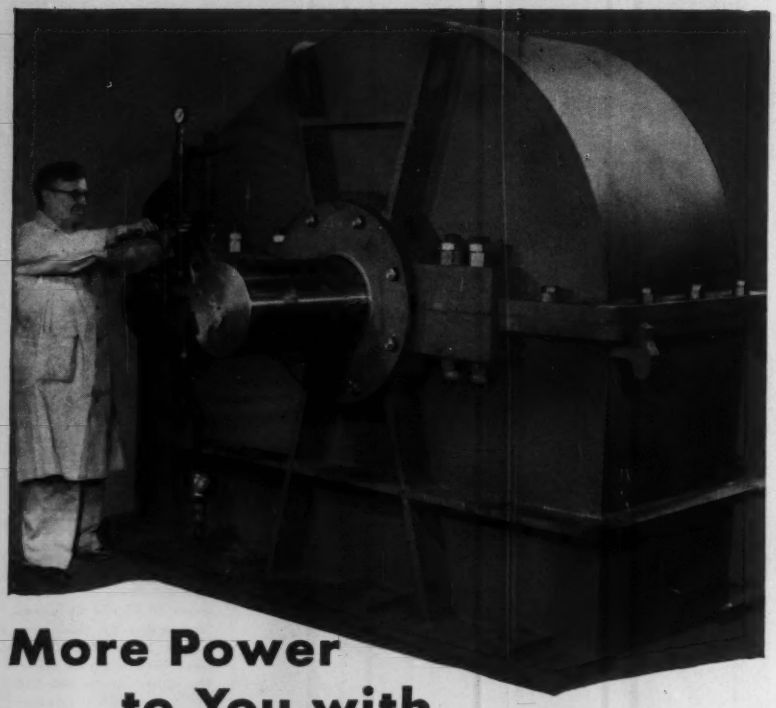
Barco "Series 850" Swivel Joints offer important advantages: (1) Built for 850 psi steam pressure rating—steel construction, hardened ball, stainless steel spring; (2) Choice of seals to handle 500°F, 750°F, or even 1000°F temperature; (3) Ability to stay in service 24 hours a day, 7 days a week, for month after month without maintenance; (4) Compact design, with Barco's distinctive "self-aligning" feature which make for quick, easy, economical pipe fitting; (5) Choice of 90°, 180° or straight body styles with threaded or welding end connections, in a range of sizes.

Engineering recommendations and detailed information on request; ASK FOR CATALOG 265D.

PRODUCTS BACKED BY EXPERIENCE
BARCO
FOUNDED 1908

BARCO MANUFACTURING CO.
521C Hough Street, Barrington, Illinois
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
In Canada: The Holden Co., Ltd., Montreal

ASK FOR CATALOG 265D



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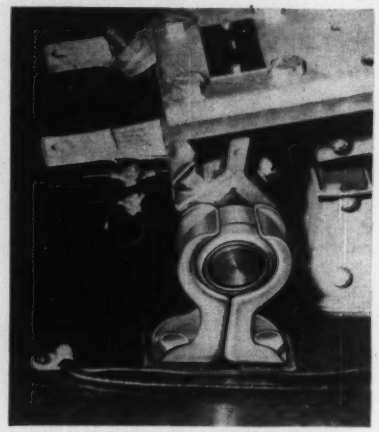

Pillow Block

A self aligning pedestal type pillow block, has been developed by Triangle Mfg. Co.

The stamped support with double-channel cross section is designed to provide an economical and sturdy mounting for sleeve type bearing ball units. The firm says the ball and socket combination for self alignment was added to speed assembly time by eliminating the need for shimming or machined surfaces. **—K-38**

Rerated Motors

The Lima Electric Motor Co., Lima, Ohio, a Subsidiary of Consolidated Diesel Electric Corp., has announced a line of dripproof electric motors in new NEMA rerated frame sizes, from ½ hp at 900 rpm through 150 hp at 3600 rpm—frames 182 through 445 urs.

The newly designed frames are rigid, seasoned, cast iron with integrally cast feet. The cast iron endbells have precision machined registers and bearing fits. Deep-drawn baffle plates in the endbells provide extra protection for the winding. Connection boxes can be rotated to make connecting easier.

The die cast aluminum rotors are equipped with dual cooling fans and the entire rotor assembly is dynamically balanced. Prelubricated sealed ball bearings require no cleaning; the correct quantity of lubricant is sealed in, dirt and moisture are sealed out.

Stator windings are impregnated with moisture-resisting, thermosetting insulating varnish, and are tested in accordance with NEMA specifications. Uniformity of the air gap between rotor and stator is accurately maintained for peak performance.

The motors can be furnished either 3 or 2 phase and in all frequencies and commercial voltages below 600 v. **—K-39**

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Code number identifies location of item in Keep Informed Section—beginning page 147.

MECHANICAL ENGINEERING—FEBRUARY 1960—Products Advertised

1	21	33	44	149	163	174	186	IFC
2	22	39	45	150, 151	164L	175	187	IBC
4	23	34	46	152	164R	176L	189	OBC
6,7	24	35	47	153	165	177L	190T	
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10, 11	26	37	49	155	169T	178L	191R	
12, 13	27	38, 39	50	156	169B	178R	192	
14	28	40	51	157	170	179	201	
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K-1	K-13	K-25	K-37	K-49	K-61	K-73	K-85	K-97	K-109
K-2	K-14	K-26	K-38	K-50	K-62	K-74	K-86	K-98	K-110
K-3	K-15	K-27	K-39	K-51	K-63	K-75	K-87	K-99	K-111
K-4	K-16	K-28	K-40	K-52	K-64	K-76	K-88	K-100	K-112
K-5	K-17	K-29	K-41	K-53	K-65	K-77	K-89	K-101	K-113
K-6	K-18	K-30	K-42	K-54	K-66	K-78	K-90	K-102	K-114
K-7	K-19	K-31	K-43	K-55	K-67	K-79	K-91	K-103	
K-8	K-20	K-32	K-44	K-56	K-68	K-80	K-92	K-104	
K-9	K-21	K-33	K-45	K-57	K-69	K-81	K-93	K-105	
K-10	K-22	K-34	K-46	K-58	K-70	K-82	K-94	K-106	
K-11	K-23	K-35	K-47	K-59	K-71	K-83	K-95	K-107	
K-12	K-24	K-36	K-48	K-60	K-72	K-84	K-96	K-108	

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Permanent Magnets

Indiana Steel Products Co., announces that Hyflux Alnico V-7, the first commercial permanent magnet to produce energy values of 7 million, is now available on a production basis.

The company reports this new high-energy material is particularly suited to special applications requiring either greater energy-per-unit weight or volume, or equal energy from a lighter or smaller magnet.

Applications include lightweight ground and airborne generators and alternators—in a full range of frequencies; meters, recording instruments, oscillographs, magnetometers and galvanometers; also missile-borne guidance and recording equipment.

Energy values provided by the magnet are due to this material's very high degree of crystal orientation, the company explains. As a result, it produces more magnetic energy-per-unit volume than the previous energy leader, Alnico V. Residual induction (B_r) of 12,750 gauss and coercive force (H_c) of 765 oersteds are also substantially greater. —K-40

VISCOSITY OF LUBRICANTS UNDER PRESSURE

This Report reviews twelve experimental investigations made in England, Germany, Japan, Russia, and the United States on 148 lubricants comprising 25 fatty oils, 94 petroleum oils, 17 compounded oils, and 12 other lubricants. Data collected are co-ordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Pertinent topics such as experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Other sections give the required computation of temperature and pressure coefficients, a bibliography of 189 items, and symbols.

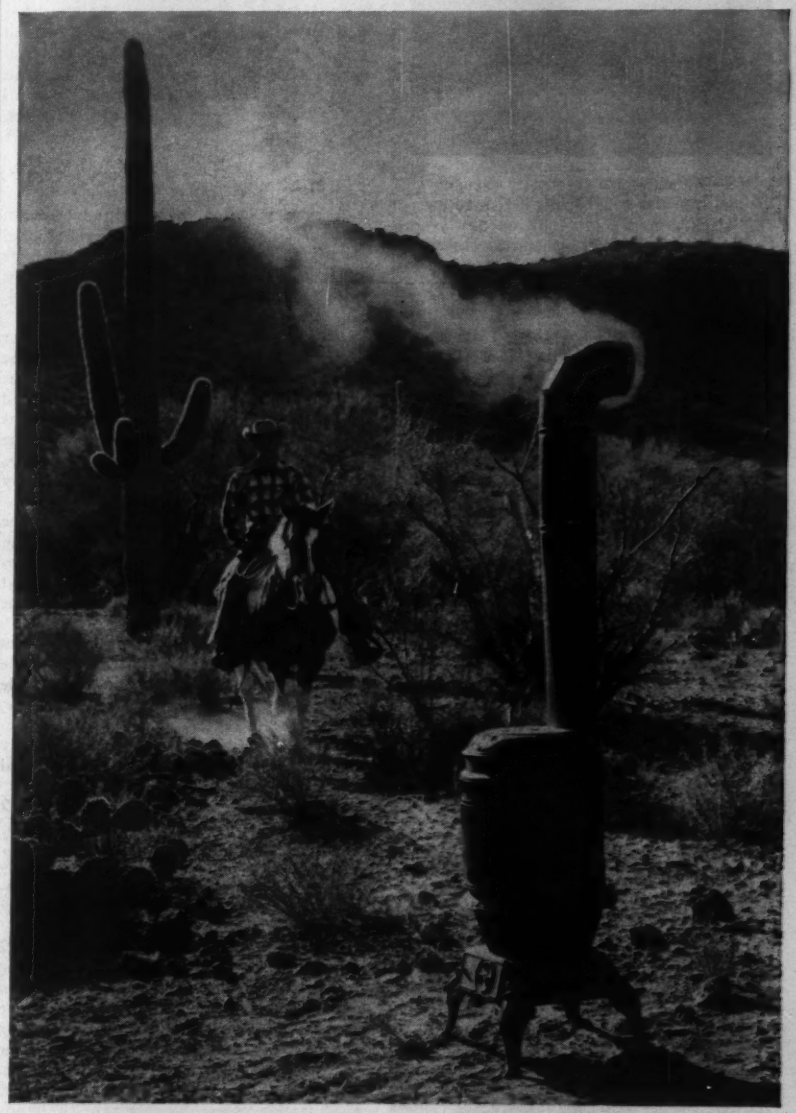
1954 $3.00

(20% Discount to ASME Members)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 W. 39th St. New York, 18.

WHEN FURNACE ATMOSPHERES MUST BE DESERT-DRY... Your gas generator manufacturer is quite likely to include a Lectrodryer when a dry controlled atmosphere is required. In this way he assures the constant dryness so necessary in many metallurgical furnace operations. Lectrodryers are long on engineering — have the built-in extra capacity that always seems to be needed. That's why they may cost somewhat more in the beginning, but cost considerably less in the long run. Ask your gas generator builder for advice on dry controlled atmospheres. For other drying help, write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 335 32nd Street, Pittsburgh 30, Pennsylvania.



Lectrodryer® McGRAW EDISON

CASH-ACME ... meeting pressure control needs for product design engineers everywhere

CASH-ACME PRESSURE REGULATING VALVE HELPS DEGREASER REACH HARD-TO-GET-AT PLACES

Oil—without which no industry can operate—can also be a liability if allowed to "stick around" too long on newly-machined parts and equipment. That's why industrymen prize their degreasing machinery so highly.

To be effective, the cleansing solvent dispelled by the degreaser must **remove every last particle of oil** from any new product. It's here that Cash-Acme Type "B" Pressure Reducing and Regulating Valve plays such a vital role. Operated by a thermostat, the valve assures the proper pressure and quantity of steam to keep the solvent vaporized. For only in this gaseous state—and under constant pressure—can the solvent reach all these hard-to-get-at places.

TYPE "B" PRESSURE REGULATING VALVE
Ready for highly intricate applications wherever accurate pressure control is vital. Single seated, spring loaded direct operating diaphragm valve. Designed for use with water, steam, air, oil, gasoline, refrigerants, and many other liquids, chemicals and gases. For Answers to Pressure Control Problems in Your Product, contact...

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666 East Wabash Ave., Decatur, Ill.

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Network Transformer

A new universal network transformer designed for either vault or subway applications and replacing the two designs formerly necessary is available from Westinghouse Electric Corp. in ratings of 300, 500, 750, and 1000 kva at 5, 15, 25, and 34.5 kv.

Improved corrosion protection for critical welded areas is said to be provided by a better film thickness of paint over the smoother and more uniform automatically welded seams of the unit's coolers. The universal design has 30 per cent fewer welds than before, but retains the features of small size, round-cornered tank and Yukon coolers, the firm reports. —K-41

Power Supply

A new precision power supply system said to be able to duplicate the varied electrical power sources found in aircraft ranging from jet fighters to bombers has been developed by Sorensen & Co., a subsidiary of Raytheon Co.

Installed at Olmsted Air Force Base near Harrisburg, Pa., the new device serves in the instrument test section. The firm says that using the varied power levels delivered by the new unit, electronic technicians and maintenance personnel can duplicate voltages found in any aircraft in order to bench-test and quickly and conveniently service the equipment.

Drawing from readily available line voltages of 208/120 v, three-phase, 60 cycles, or 120 v, single phase, the single unit provides a gamut of power choices for technicians at adjacent benches who can plug-in the particular power required.

The new power supply system delivers precisely regulated 28 v d-c; 115 v, single phase, 60 cycle a-c; 115 v and 26 v, single phase, 400 cycle a-c; and 115 v. and 26 v, three phase, 400 cycle a-c.

The 400 cycle power supply is continuously and precisely adjustable between 360 and 440 cycles per second, the firm reports. —K-42

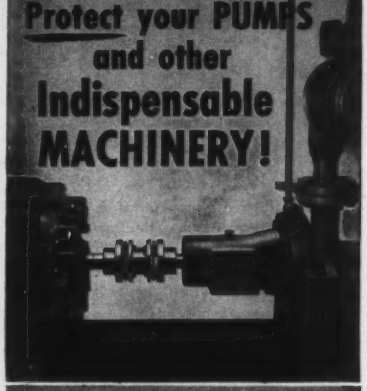
High Pressure Filters

New high pressure filters capable of operating at pressures to 1000 psi and temperatures to 275 F have been introduced by Purolator Products, Inc.

The new filters, designated the P-192 series, are designed for use in pneumatic and hydraulic systems to provide filtration for such fluids as lubricating oils, ethylene glycol mixtures, hydraulic fluids (including mineral oil base, silicate esters, and diester oil base), fuel, and oils, plus air and gases. Any model in the new series can be adapted for filtration of many other types of fluids by simply changing to the proper gasket material, the firm reports.

Design of the series permits use of replaceable paper elements, wire mesh, or varied-spacing metal-edge filtering media. —K-43

THOMAS FLEXIBLE COUPLINGS Protect your PUMPS and other Indispensable MACHINERY!



NO LUBRICATION
NO MAINTENANCE
NO WEARING PARTS

Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.
They will protect your equipment and extend the life of your machines.
Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES:

- Freedom from Backlash
- Torsional Rigidity
- Free End Float
- Smooth Continuous Drive with Constant Rotational Velocity
- Visual Inspection While in Operation
- Original Balance for Life
- No Lubrication
- No Wearing Parts
- No Maintenance

Write for Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Electronic Inspector

A machine that can inspect production line output quicker than the human eye has been developed by American Machine & Foundry Co.

Said to be the first portable electronic device to measure production line standards and quality control, the new standard deviation meter electronically counts, weights, computes, and records the individual standard deviation of production line items.

It compares each product with its average standards and then computes the deviation from the standards. The firm says complete measuring procedure is done in approximately one-hundredth the time required by manual methods for the same operation.

First application of the machine will be in the cigarette manufacturing industry where it will monitor cigarette production and maintain quality and weight standards. The machine will check the standards of 2000 finished cigarettes in less than two minutes, the company reports. —K–44

Servo Valve

Kearfott Co., Subsidiary of General Precision Equipment Corp., announces the availability of its 6104 electrohydraulic servo valve uniquely designed to provide extreme reliability under the most severe environments encountered in high performance hydraulic systems.

Constructed of titanium, the unit features the firm's exclusive development of unity-coupled hydromechanical feedback, which is said to substantially reduce flow force reactions and accomplish hydraulic centering of pilot position without spring hysteresis and null shift.

Springs and mechanical null adjustments are eliminated and high null accuracy is provided by an electrically operated balancing control.

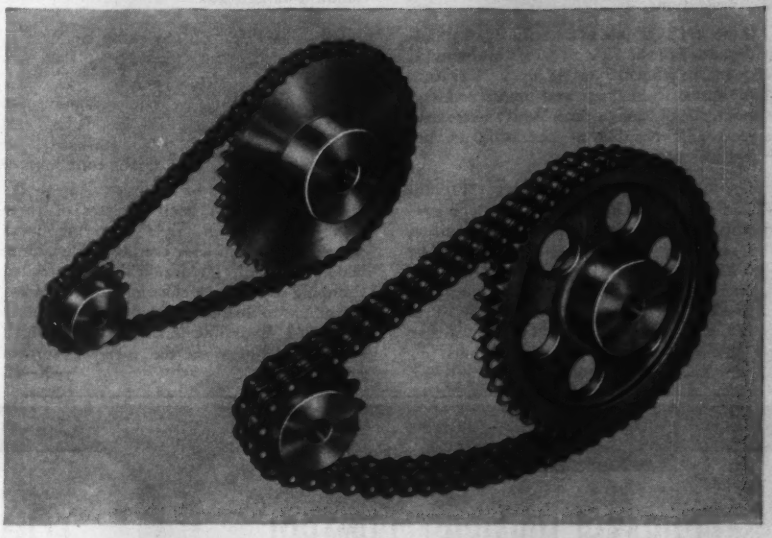
The valve contains two moving parts. The unit is basically a two-stage, four-way flow control valve. An electrical torque motor and shear seal orifice hydraulic amplifier constitute the first stage, and matched spool and sleeve arrangement constitute the second or control stage. —K–45

Spray Gun

Metallizing Engrg. Co. has announced a new spray gun utilizing the plasma-arc principle to develop normal work temperatures of 10,000 to 15,000 F and spray any material that will melt without decomposing.

Designed for push-button operation in the user's own plant, the gun is said to provide a practical means of applying coatings of high melting-point materials such as zirconium carbide (3540), tungsten (3370) and tungsten carbide (2850), zirconium boride (3000) and zirconium oxide (2700), niobium carbide (3900). —K–46

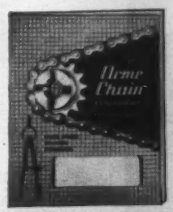
DO YOU HAVE THE PROPER CHAIN SELECTION FOR YOUR EQUIPMENT?



If there is a question in your mind about the correct size of chain to use for your particular installation, save time and money by consulting ACME Engineers at once. They will assist you in selecting the proper chain drive. In many instances, this depends on how much horsepower you want to transmit . . . the speed and size of your shaft . . . space limitations . . . hours of continuous operations, etc.

These are problems on which our engineers can draw from their many years experience to give you the correct answers.

Consult your nearest ACME Distributor or write our Engineering Department for the answer to your CHAINING PROBLEMS.



Write Dept. 11-C for new 100-page illustrated technical catalog including new engineering section showing 36 methods of chain adjustments.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

D-C Accelerometer

Giannini Controls Corp. has expanded its inertial instrument line by the addition of the Model 24124 d-c accelerometer with a potentiometric output.

The instrument is small in size (1 × 1.5 × 1.4 in.), light in weight (less than 4 oz), and has a low natural frequency with relative high resolution.

Units are available in a flexibility of standard ranges from ±5 g's to 50 g's and natural frequencies from 15 to 48 cps. The firm says hermetic sealing and unique design characteristics make the unit extremely rugged and capable of operation in unfriendly environments.

The units will withstand 50 g, 11 millisecond shock and 50 g steady-state acceleration in any axis without structural damage, the company reports. Fluid damping (0.6, ±1 of critical) is provided at low temperature to minimize shock and vibration. Operating temperature range is −54 to +71 C with an accuracy band of ±5 per cent for overall environmental conditions including linearity and hysteresis. **—K–47**

Scrap Handler

A 1200-lb capacity, hydraulic scrap handler attachment capable of dumping at a height of seven feet has been developed for the firm's Y-18 industrial tractor shovel by Yale Materials Handling Div., Yale & Towne Mfg. Co.

High capacity of the claw-like unit permits handling large loads of lathe turnings, light gage blanking scraps, bales, hides, strips, or other objects that do not easily conform to normal bucket type handling, the firm reports.

The attachment's hydraulic dumping action and high reach allow for loading this material into normal open truck carriers or collecting it in tall, space-saving containers or piles.

The attachment itself consists of three components: seven, rigid, carrying forks welded to a 48-in.-wide carriage; four, more widely spaced, hydraulically controlled clamping forks which close against the carrying units to hold the load and separately controlled hydraulic kick-off forks which sweep material from the carrying surface in dumping. **—K–48**

Flush Mounted Valves

Hydrodyne Corp. has announced the production of a flush mounted fuel control valve.

Designed for a specific aircraft application, it is manually operated and comes in either a normally opened or normally closed position. It is manufactured on aluminum and is designed to handle JP4 fuel. **—K–49**

BUSINESS NOTES

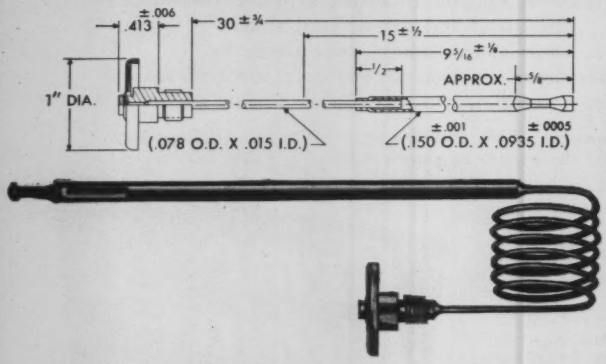
Western Division Facility

Barry Controls has announced the acquisition of an expanded facility to house its west coast operations.

Located at 1400 N. Flower St., Glendale, Calif., the new structure will house complete sales, engineering, and manufacturing facilities. The company manfactures shock and vibration controls and shock testing machines.

TEMPERATURE SENSOR

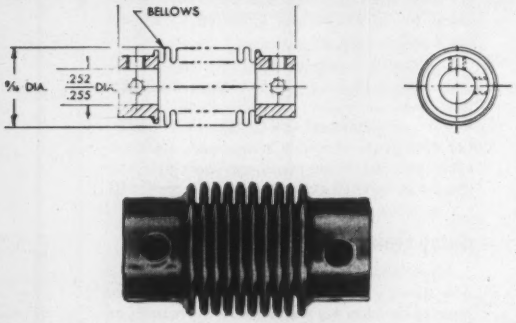
ACCURATE, NO-DRIFT CONTROL FOR APPLIANCES SOLVED BY ROBERTSHAW DIASTAT® ASSEMBLY



Temperature sensing elements like this one for a range oven control offer permanent accuracy with no drift, consistent calibration, no resetting, long life and savings in space, weight and unit cost. Ambient temperature sensing devices are unnecessary in most applications. Typical stroke is .035″ for a 1″ diameter stainless steel diaphragm. Ideal for sensing temperatures up to 650°F. All units are custom engineered and delivered as pre-assembled "packages," tested and ready for mounting. WRITE FOR BULLETIN D-602

FLEXIBLE COUPLING

ELIMINATE BACKLASH, END-PLAY! ABSORB VIBRATION, SHOCK WITH ROBERTSHAW FLEXIBLE COUPLINGS



Servomechanisms, instruments and similar drive and control systems are the big users of these small, flexible units. Ideal for guarding against misalignment friction and bearing wear problems. Save space and weight. Cut down noise. Simplified design utilizes seamless metallic bellows, in choice of several metals, connected to two hubs. Sizes from 15/32″ O.D. Stock sizes accommodate shafts from ⅛″ to ½″. Other sizes custom-engineered. WRITE FOR DATA SHEET D-802

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Milwaukee Warehouse

Latrobe Steel Co. manufacturer of tool, die, and specialty steels announced today the establishment of a warehouse facility for its line of Badger oversize flat ground stock at Milwaukee. It will be housed at the American Warehouse Co., 525 E. Chicago St. Orders will be handled by Latrobe Steel's Milwaukee office.

Electronics Plant

A new plant for the manufacture of RCA industrial electronic products will be constructed in the Washington-Cannsburg, Pa. area.

The plant, the second new Pennsylvania facility to be announced by RCA in recent months, will provide space to accommodate the firm's expanding industrial electronic product activity, the company reports.

Use a CLASSIFIED ADVERTISEMENT *for Quick Results*

Opens Teflon Plant

Crane Packing Co. has completed the first plant devoted exclusively to the full scale processing of Du Pont Teflon.

Included are facilities for processing basic Teflon shapes (sheet, rod, tubing, and tape) and the manufacture of both standard and custom proprietary items.

LATEST CATALOGS

Crane-Excavator

American Hoist & Derrick Co., has released a new 24-page catalog, No. 730.CG-2, on its 300 series crawler crane-excavator.

The catalog describes and illustrates the features of the machine and outlines its versatility on many different type jobs, such as crane, magnet, clamshell, dragline, shovel, and backhoe. —K-50

Bin Level Control

Stephens-Adamson Mfg. Co. has announced the availability of Bulletin 159 on Tellevel bin level control switches.

The literature features technical and engineering data, specifications, diagrams, and illustrations on the normal duty explosion proof and heavy duty switches. —K-51

Grinding Wheels

Built-in guard safety cup wheels for portable grinding in steel mills, foundries, and welding shops are the subject of a folder issued by Carborundum Co., Niagara Falls, N. Y.

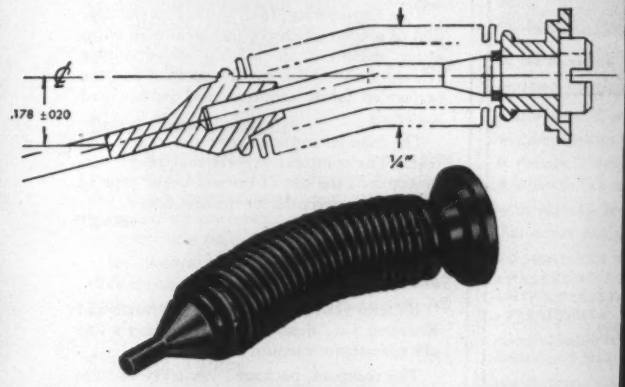
How they are made, their features, specifications, recommendations, and how to order information is contained in the folder.—K-52

New Machinists' Tools

The Brown & Sharpe Mfg. Co. recently released new Machinists' Tools Catalog No. 37M. This catalog of 48 pages lists the firm's tools generally used by machinists and toolmakers. —K-53

MINIATURE BELLOWS

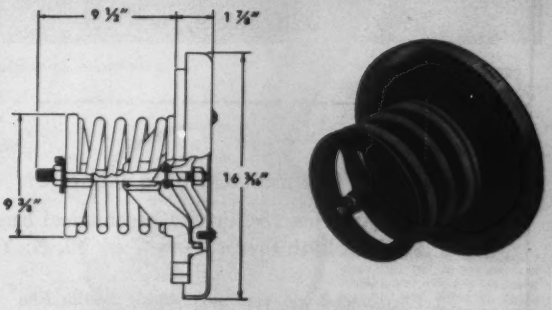
SAVE SPACE AND WEIGHT WITH RUGGED, MINIATURE ROBERTSHAW METALLIC BELLOWS



Seamless metallic bellows only ¼" and 5/16" O.D. permit further miniaturization in aircraft, missiles, instruments and other equipment. Available in a wide range of bellows metals to provide the desired strength and performance characteristics. Sensitive to temperature and pressure changes. Custom-engineered . . . but available in any quantity you need. Proved in dozens of miniaturized assemblies. WRITE FOR BULLETIN D-102

PRESSURE RELIEF VALVE

VENTS PRESSURE BUILD-UP IN TRANSFORMERS, TANKS . . . RESEALS AUTOMATICALLY WITH NO RESETTING!



Now you can forget breakaway seals that have to be replaced each time dangerous high pressure build-ups are relieved. Robertshaw Pressure Relief Valve operates instantaneously. No moisture or contaminants can enter vessel during blow-off or automatic resealing and resetting. No periodic inspections necessary.
WRITE FOR ENGINEERING DATA SHEET D-902

Robertshaw

BRIDGEPORT
THERMOSTAT DIVISION
Milford, Conn.

IS YOUR COMPANY LISTED?

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Use your 1960 volume to check your company's listings in the Directory Section.

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KEEP INFORMED

Power Convection

Heat treating furnaces in which the principle of power convection is used, are described in an eight-page, two-color folder, Bulletin SC-182, issued by Surface Combustion Corp.

Applications of the systems which are claimed to be achieving unprecedented rates of heat transfer are shown photographically, along with schematic flow diagrams of typical systems. —K-54

Deep Drawn Parts

An illustrated bulletin, offering basic information on the use of deep drawn parts in production, has been issued by Pressed Steel Tank Co., 1445 S. 66th St., Milwaukee 14.

It tells which metals can be specified for deep drawing; how parts are formed; which types of standard and special shapes and shells can be produced—alone or in combinations; how deep drawn parts improve products, speed production, cut costs. —K-55

Cooling Tower Drives

High horsepower worm gear Type-CU drives, designed specifically for cooling tower service, are featured in Bulletin No. 135-S, available from Cleveland Worm & Gear Co. The compact speed reducers are designed to quietly handle heavy-duty fans under extreme conditions of heat and humidity. The brochure gives sizes, dimensions, horsepower ratings. —K-56

Vibration Control

Voss Engineering, Inc., announces publication of a comprehensive technical manual to assist engineers in solving objectionable vibration and shock conditions with Sorbtex preformed fabric neoprene and rubber pad materials.

The manual contains reference charts and text. The company reports that many new concepts in the use of its non-linear type of isolator are presented for the first time. —K-57

Jet Vacuum Pumps

Bulletin 5H-HS, published by Schutte and Koerting Co., describes the company's line of hydro-steam vacuum units.

The compact, packaged low-level vacuum producers are said to fit in minimum floor space and require little head room; no barometric leg is employed. The firm says only minimal piping connections and installation work are required. The units are available in single-stage, two, three, four, and five-stage types. —K-58

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Bearing Blocks

Information on Link-Belt Co. line of babbitted, bronze, and plain bore bearing blocks and takeups is presented in a 16-page book, 2707.

In this publication the company announces the addition of 119 new sizes, in eight series, to its line. With the new additions the firm says it offers off-the-shelf delivery on more than 15 types and over 300 sizes of solid, split, gibbed, angle, or flanged pillow blocks for commercial shafting up to 12 in. in diameter. —K–59

Hydraulic Press Brake

A 16-page catalog describes the line of hydraulic press brakes produced by Verson Allsteel Press Co.

The catalog gives specifications on models ranging in capacity from 150 to 1800 tons plus information on design details and photographs of typical models. —K–60

High Pressure Pump

A 12-page bulletin on high pressure pumps has just been published by Autoclave Engineers, Inc.

In addition to data on hand operated, motor driven and air operated pumps, the bulletin also includes information on some principal uses of such equipment in both high pressure research and production operations. —K–61

Abrasive Slurries Valve

United Conveyor Corp. has issued Bulletin No. 159-A describing a newly developed valve for abrasive slurry applications. It can be installed in any position and has no slots or guides interfering with valve movement. Maintenance reduced to a minimum since there are no sliding metal to metal parts, the firm states. —K–62

Spiral Point Geometry

Cincinnati Lathe and Tool Co. announces Catalog SP-165, a 24-page booklet describing the firm's revolutionary new spiral point geometry for converting standard twist drills into precision tools.

It illustrates cost-reducing advantages that are obtained, and shows operation of the Spiropoint drill sharpening machine.—K–63

Stainless Tubing

A technical data card published by Tubular Products Div. Babcock & Wilcox Co., describes the high temperature properties of Croloy 25-12 (309) stainless tubing, pipe, and fittings. It covers chemical composition, size ranges, and short time tensile and rupture properties. —K–64

FOR REDUCING OR SALVAGING MATERIALS
it's profitable to consult
American

Got a waste product problem? Got tons or pounds of chemicals, plastics, ceramics, metallics, or any other material you'd like to reduce for resale or reuse?

Send samples of any material you desire to American, and let our engineers apply their reduction experience to your particular reduction or salvage problem. No obligation. Send samples, not over 50 lbs., F.O.B. St. Louis.

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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
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Allflex
STAINLESS STEEL
"MNH" FLEXIBLE CONNECTORS

A NEW stock answer to pipeline problems caused by rigid connections.

- Dampens Vibration
- Compensates for Misalignment
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- Absorbs Expansion

With ALLFLEX Stainless Steel Connectors you get

- CORROSION RESISTANCE . . plus
- PRESSURE RESISTANCE . . plus
- HEAT RESISTANCE . . plus
- FLEXIBILITY

Also available in Monel, Bronze and Steel.

WRITE TODAY for fact-filled ALLFLEX Bulletin

THESE STOCK SIZES
¼" ⅜" ½" ¾"
1" 1¼" 1½" 2"

IN THESE STOCK LENGTHS
12" 18" 24" 30"
36" 48" 60"

SHIPPED FROM FACTORY SAME DAY ORDER IS RECEIVED

Also available in all standard sizes thru 10", in any required lengths, and with any special or standard end fitting or flange connections. Send your problems to Allied's Engineering Department. Let us suggest the best solution for your flexation problems.

ALLFLEX Standard Stainless Steel Connectors are sold through leading Industrial Distributors. If not available locally—remember THEY CAN BE SHIPPED FROM FACTORY SAME DAY ORDER IS RECEIVED.

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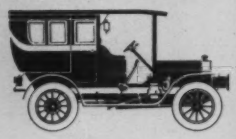
SINCE 1874 SLY

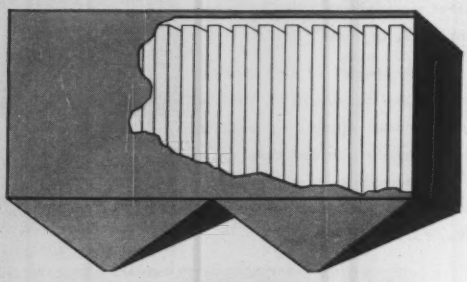
SLY DUST FILTERS For Maximum COMPACTNESS

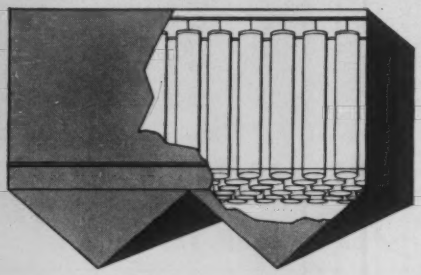


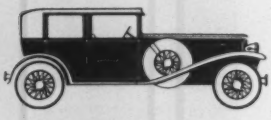
1900's

SLY DUST ARRESTER

47% less filtering area per cubic foot of filter.







1930's

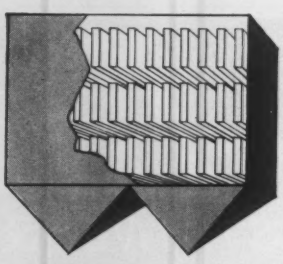
SLY TUBE-TYPE FILTER

37% less filtering area per cubic foot of filter.

TODAY

NEW SLY "ROLL-CLEAN" DYNACLONE®

Most filtering area per cubic foot of filter.



SLY DUST FILTERS PROVIDE 20 TO 40% MORE CLOTH IN A GIVEN SPACE THAN ANY OTHER DUST FILTER.

The new "Roll-Clean" Dynaclone gives: Continuous cleaning, constant suction and complete accessibility in the least possible space.

Space saved with the Dynaclone means: Lower installation costs, lower building costs, simplified piping and ductwork.

Only the Dynaclone furnishes: A single exhaust fan that does the entire job, providing *both* suction for dust collection *and* air for bag cleaning. No auxiliary blowers required.

New "Resist-O-Wear" bags in the Dynaclone offer: 200 to 300% more bag life, easier bag changing, simplicity of construction, and *job-proved* ruggedness.

More than 40,000 Sly Dust Filters in operation, including over 1,000 Sly Dynaclones, prove their advanced design. See for yourself . . .

SEND FOR 36-PAGE CATALOG 104

THE W. W. SLY MANUFACTURING CO.

4768 Train Avenue • Cleveland 1, Ohio • Offices in Principal Cities • Overseas Licensee: Andrew Air Conditioning Ltd., London S. W. 1, England

KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Flame-Retardant Laminate

Fireban X, a new flame-retardant version of Grade X laminated plastic, is described in a Technical Bulletin 3.1.1.1 offered by Taylor Fibre Co.

The bulletin describes the material as a paper base grade with low phenolic resin content. It was developed for use where both mechanical strength and flame retardance are required. Typical applications, the bulletin notes, are structural parts for radio, aircraft, and switchgear; terminal boards or panels, and insulating washers. —K-65

Flexible Couplings

Thomas Flexible Coupling Co. announces the distribution of Catalog No. 60.

Misalignment is described, and assistance is given in selecting a coupling. Loads are classified in a new way, and various types of couplings are grouped for easier selection. Photographs of couplings and installations, diagrams and tables for each type of coupling comprise the main part of the catalog. —K-66

Heating Coils

A 32-page bulletin, No. HC-102, describing the construction and operation of the Kennard/Nelson heating coils has been released by American Air Filter Co.

The bulletin contains explanations, graphs, charts, and illustrations for standard steam, hot water, steam distributing and double distributing coils. Included are air friction charts, temperature rise charts for pressures ranging from 2 to 30 lb steam, condensate rates, water velocity and pressure drop graphs, heat transfer factor graphs, MTD chart. —K-67

Thermocouple Insulators

A revised bulletin on high purity insulators for sheathed thermocouples has been published by Norton Co.

It describes the uses and technical specifications of fused magnesium oxide, aluminum oxide, and zirconia thermocouple tubing used in connection with aircraft turbines, atomic reactors, and other situations where accurate temperature measurement is important. —K-68

Stationary Compressor

A 24-page bulletin describing its WN-112 stationary air compressor has been released by Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa.

The booklet contains specifications, diagrams, cross section drawings, installation photographs. The V-vertical compressor is built for continuous, heavy duty service for pressures to 125 psi with piston displacements from 468 to 974 cfm. —K-69

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Steel Abrasive Data

Performance and statistical data compiled in abrasive research and experimentation is revealed in a new handbook of blast cleaning abrasive performance, Bulletin 903-D, offered by Wheelabrator Corp.

Topics discussed include: how performance controls economy in blast cleaning abrasives, how abrasive breakdown characteristics affect finishes and cleaning costs, how abrasive hardness affects cleaning speed, how abrasive size affects finish quality, how to control the finish achieved by airless blast cleaning. —K-70

Resistors, Kit

A catalog sheet describing its multi-range resistor line and multi-range kit has been published by International Resistance Co.

The complete line, which is also available in the kit package, comprises five basic units, but provides 200 fixed resistance values. The multi-range idea, on which patent is pending, uses four separate 10-w wire-wound resistors, all encased in a common steatite housing. —K-71

Aircraft Steels

A booklet on its aircraft steels AM-350 and AM-355 is being distributed by Allegheny Ludlum Steel Corp.

The 24-page booklet gives detailed information on the steels as to their mechanical and physical properties at various temperatures. Also included are sections on heat treating, fabrication, including forming, forging, welding, brazing, and machining. Tables giving detailed data are included. —K-72

Pressure Transducer

A new bulletin containing specifications on its Model 717 absolute pressure transducer has been released by Bourns, Inc.

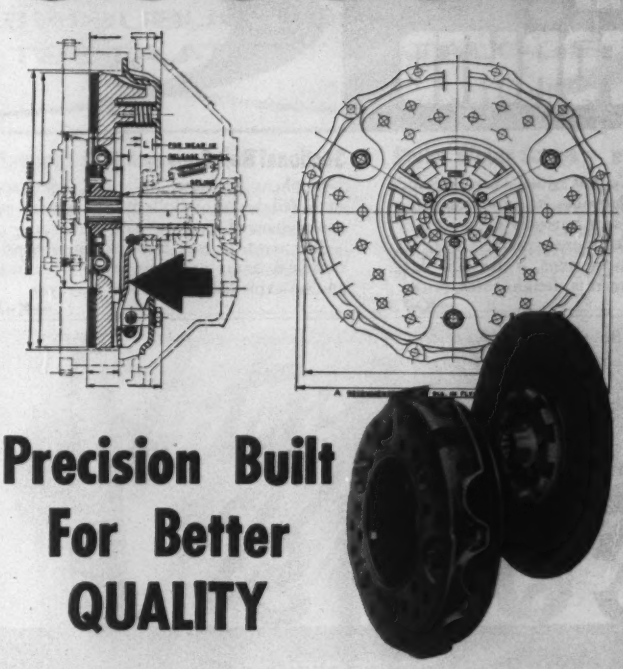
This instrument employs a unique Bourdon tube movement that assures reliable and accurate operation to 35 G's at 2000 cps vibration, the firm reports. It is designed to offer negligible friction by eliminating all mechanical linkages, bearings and multiplication. —K-73

Frequency Meters

Data on Frahm precision frequency meters, with guaranteed permanent accuracies of ± 0.1 per cent of calibrated frequency, is offered by James G. Biddle Co.

The meters in miniature, switchboard, and portable types are available in various ranges between 10 and 1700 cps and signal voltages from millivolts upwards. They are designed for continuous operation and are independent of wave form and exact input voltage. —K-74

ROCKFORD



Precision Built For Better QUALITY

Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

ROCKFORD Precise Workmanship provides clutch levers that reduce friction, improve release action and prevent lever throw-out. These wear-resisting, life-lengthening clutch features are covered by patents and are essential to designs that must be projected with a thought to uses of tomorrow. ROCKFORD CLUTCHES provide the advantages of heat-treated, hardened and ground steels—flat, non-grab facings—heat dissipation—dirt exclusion—and fine accurate adjustments. ROCKFORD engineers now are working with many companies on their future designs—to provide custom-engineered clutches for long range economy. Their services are available to you at your convenience.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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CLUTCHES

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Butterfly Valve

Henry Pratt Co. has issued a catalog which illustrates and describes its new Monoflange Mark II rubber seat butterfly valve.

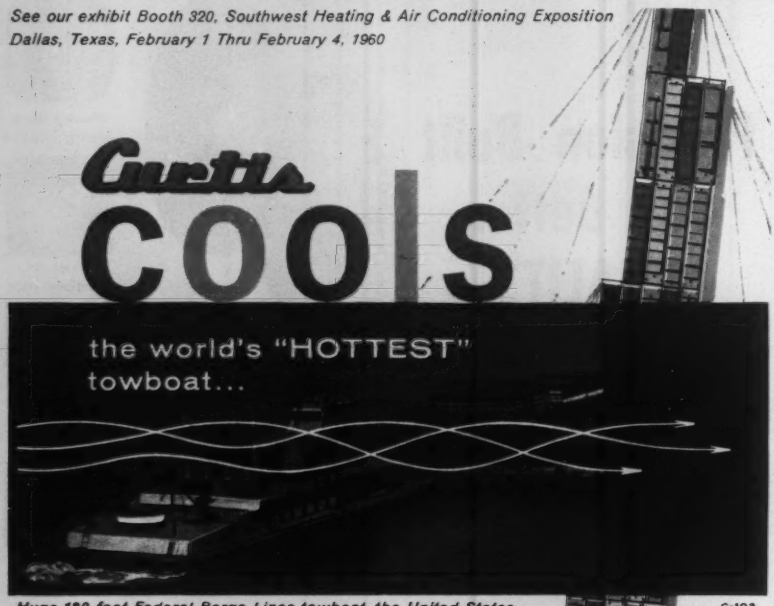
The catalog contains specifications, certified dimension drawings, water flow data, gas flow data, weights, freight rates, prices. —K-75

Sectional Belt Conveyor

Stephens-Adamson Mfg. Co. announced the availability of Bulletin 458 on its new pre-engineered sectional belt conveyor.

The new literature features comprehensive technical data, pre-engineering advantages and an exploded view of the conveyor. —K-76

See our exhibit Booth 320, Southwest Heating & Air Conditioning Exposition Dallas, Texas, February 1 Thru February 4, 1960



Huge 180 foot Federal Barge Lines towboat, the United States, has 50% greater horsepower than the largest towboat on the rivers. It can push 40 barges, totaling 1/3 mile, or 300 ft. longer than the "Queen Elizabeth".

C-103

Space saving design versatility? Easy installation? Operating dependability? Comparative cost? All these factors were considered by St. Louis Shipbuilding and Steel Company in the selection of air conditioning equipment for the world's most powerful towboat. The shipbuilders' and their design engineers' careful choice? A Curtis 20-ton packaged liquid chiller system. This equipment will cool the crew's quarters, galley, mess room, officers' and guest quarters—all with individual room or area temperature control.

The Curtis complete line, and reputation for dependability in installation of all types, work to the benefit of engineers and mechanical contractors. Factory run-in of all units cuts call backs far below average. You can safely promise dependable performance always up to, and frequently surpassing, rated capacity. You eliminate your problems when you specify Curtis, because you're working with an outstanding manufacturer of air conditioning equipment.

THE COMPLETE LINE OF LIQUID CHILLERS • PACKAGED AIR CONDITIONERS • CONDENSING UNITS

Curtis *ESTABLISHED IN 1854*

MANUFACTURING COMPANY • REFRIGERATION DIVISION • *St. Louis 33, Missouri*

Power Transmission

A brief, comprehensive review of its line of power transmission machinery is presented in an eight-page bulletin by Dodge Mfg. Corp.

It features Flexidyne dry fluid drives and Para-flex flexible cushion couplings, two of the newest products in the line, and also offers illustrated descriptions of such Taper-Lock products as steel conveyor pulleys, roller chain drives, various types of shaft couplings, and the new, compact Dyna-V line of V-belt drives. —K-77

High Speed Indexing

Ferguson Machine Corp. has issued a 24-page catalog, No. 108, giving data on high speed, precision, roller gear drive indexing mechanisms for achieving intermittent and oscillating motions.

Included are units rated for speeds up to 2000 indexes a minute with prevision of .001 in. and zero backlash for 8000 to 20,000 hr operation. Stock and standard components and housed units are shown, as well as Trans-Pac power assemblies, standard right angle drives and gear reducers. Information for calculating load requirements and designing an installation is provided. —K-78

Submersible Pumps

Thirty-two leading, fully-illustrated and indexed uses of submersible pumps highlight a 1960 catalog-data file now being distributed by Kenco Pump Div., American Crucible Products Co.

The catalog lists physical dimensions, pumping capacities, electrical data, and specific features for each pump together with engineer's specification forms as guides for specifying each pump. A directory of factory-trained service centers is included together with its exchange pump plan and service policy. —K-79

Packers, Jolters

Syntron Co. announces the availability of a four-page catalog section on pulsating-magnet vibratory packers and hydraulic jolters, designed to speed packaging and reduce container costs by increasing the net content of containers as much as 20 to 30 per cent.

Illustrated catalog presents descriptions, data, and specifications for eight standard electromagnetically vibrated packers and for two standard model fluid-power jolters. It also contains illustrations of typical applications and installations. —K-80

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Planetary, Star Gears

Gears for speed reduction or speed increasing service on high-horsepower transmission applications are described in an eight-page bulletin available from De Laval Steam Turbine Co.

Bulletin 2401 covers eight sizes of planetary and star gears, used for boiler and feed and circulating water pump drives, compressor and blower drives, and as drives for turbines and internal combustion engines. The bulletin includes cutaway drawings, information on construction details, capacity and selection curves, selection examples, and tables of dimensions. —K–81

Sub-Miniature Valves

Specifications and performance information on Trim Line valves by Hunt Valve Co. are contained in a 12-page bulletin, No. 592.

Valves are 1 in. thick by 1 1/2 in. wide, available in six valve actions. They are designed for controlling small cylinders or operating diaphragms, pilot cylinders where mounting space is extremely limited. A cutaway view shows details of valve action. —K–82

Proximity Switch

Micro Switch Div., Minneapolis-Honeywell Regulator Co., announces the release of preliminary data sheet No. 163, a four-page publication of technical information on its new proximity switch.

Included in the data sheet are photographs, dimension drawings, and descriptive diagrams of sensitivity range, sensitivity envelopes, mounting requirements, and wiring instructions. Information on operating and electrical characteristics, prices is also included. The switch is described as a device which senses ferro-magnetic material without physical contact. —K–83

Tube Data Memo

Shaped tubing in square, rectangle, elliptical, oval, and a great variety of other cross sections is illustrated and described in data memorandum No. 17 published by Superior Tube Co., 1715 Germantown Ave., Norristown, Pa.

Analyses in which the shaped tubing is furnished include stainless steel, carbon and alloy steels, nickel and nickel alloys, glass sealing alloys, titanium and beryllium copper. The data memorandum describes methods of manufacture and tool charges, tempers, and lengths in which furnished. It lists commercial tolerances for several types of shaped tubing. Also discussed are Bourdon, step-tapered and mechanical tubing. —K–84

Magnetic Clutches

PIC Design Corp., a subsidiary of Benrus Watch Co., is offering an 18-page booklet on magnetic clutches and their applications.

The booklet has details on design, applications, technical and testing specifications. —K–85

Boiler Water Gages

Jerguson Gage & Valve Co. has issued Bulletin 360 on its new Refracolor gages.

These gages are for high pressure installations and they clearly show the water level as green, while the steam area shows red. —K–86

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- both horizontal and vertical designs
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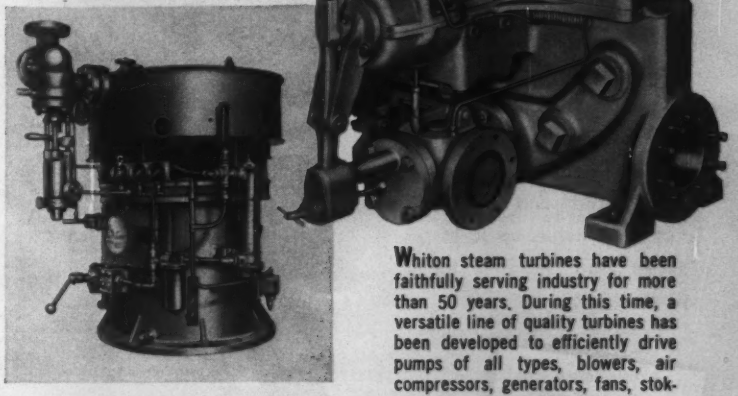
- for industrial and marine applications



Whiton steam turbines have been faithfully serving industry for more than 50 years. During this time, a versatile line of quality turbines has been developed to efficiently drive pumps of all types, blowers, air compressors, generators, fans, stokers, and other process equipment.

Equipped with such features as constant speed governor, separate overspeed emergency stop and dynamically balanced rotor, speeds are obtainable to 8500 RPM suitable for steam pressures to 1250 psig and temperatures to 1050° FTT.

For complete specifications, contact The Whiton Machine Company or the Whiton representative nearest to you.

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THE WHITON MACHINE COMPANY
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Gas-Powered Fork Trucks

A four-page color brochure, Bulletin No. SS-2060, giving dimensions and engineering specifications of the Clarklift C-25, a gas-powered fork truck of 2500 lb capacity, is available from Industrial Truck Div., Clark Equipment Co.

Drawings illustrate construction and operational features. A grade and drawbar pull chart and upright dimension table are included. The unit is equipped with cushion tires for indoor work, and has all standard features. —K–87

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Pickup Compressor

A six-page bulletin on its DM-125 packaged compressor, 300 hp class, is available from Cooper-Bessemer Corp.

Bulletin 92 reviews the need for small horsepower, heavy-duty integral engine-driven compressors specifically designed for field gathering service. Power unit and compressor cylinders used in the packaged construction of the DM-125 are discussed, along with operating characteristics. Articulated connecting rod construction and crosshead and guide assembly are illustrated, as well as overall dimensions. —K–88

Variable Delivery Pumps

A new series of fixed angle variable delivery (FAV) hydraulic pumps for aircraft and missiles, is described in a six-page brochure, Bulletin A5233A, released by Vickers Inc., Div. of Sperry Rand Corp.

The brochure illustrates and describes the pumps as providing the power savings and low heat rejection of variable delivery, having the minimal package size and weight characteristics of fixed displacement units and exceeding new military specification MIL-P-19692 for service life requirements and contamination tolerance. —K–89

Gas Turbine Engine

A catalog sheet which describes the Turbo-Mite lightweight, miniature gas turbine engine is available from Santa Barbara Div., Curtiss-Wright Corp.

The sheet describes the unit as a twin-spool coaxial machine of exceptional compactness and flexibility of operation, quick-starting in any temperature and suitable for use as an auxiliary power unit, a portable pumping system, or as a portable pneumatic system source. It weighs 30 lb and is available in 5 and 10 hp models. —K–90

Spherical Bearings

Link-Belt Co. is new line of highest capacity spherical roller bearings is described in detail in a new 52-page book, No. 2760.

The book describes all design features, including comprehensive selection data and formulas, shaft bearing seat diameters, lubrication information, shaft details and bearing load ratings, diagrams, photographs, and charts. —K–91

Speed Reducers

Industrial Products Div. Western Gear Corp. announces the availability of Bulletin 5908 which contains engineering information and specifications on the SpeedMaster line of vertical-helical speed reducers.

The bulletin covers both double and triple reduction reducers and includes selection instructions covering many different types of installations. —K–92

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Sugar Clarifier

A ten-page color booklet on the new Prima-Sep sugar clarifier is available from Graver Water Conditioning Co.

The booklet contains data on the clarifier, how it operates, how it performs at 25 per cent greater capacity than other designs and why the manufacturer says it provides the most complete clarification for all types of sugar cane juice. Details of design and construction are included, with engineering cut-away drawings of the internal and external design and the flow pattern in the unit. —K–93

Fittings, Valves

A 20-page catalog on automatic, semi-automatic, and regular quick detachable couplers is available from Foster Mfg. Co.

This catalog contains information on the firm's line of chrome sleeve fittings of all types, and shows practical applications of couplers, fittings, hose, and 3-way sleeve valves to use with various air-operated tools and fixtures. —K–94

Dihedral Coupling

John Waldron Corp., New Brunswick, N. J., has announced the publication of a two-page data sheet on its newly developed Series X dihedral coupling.

The bulletin includes diagrams of the coupling and parts, a table of sizes and bores, and complete information on design and construction of the units which permit up to a 5 deg misalignment capacity. —K–95

Rubber Bonded Abrasives

Rubber bonded abrasives for polishing and finishing such as rubber bonded polishing wheels, unfinished sticks and stones, special purpose stones, and wheel dressers and sticks are featured in a folder issued by Carborundum Co., Niagara Falls, N. Y.

Their special function and types of materials on which they are particularly useful, specifications, and prices are covered in the folder. —K–96

Leaded-Steel Forgings

The fall-winter issue of the ALCO Review, product publication of ALCO Products, Inc., features a five-page article on the advantages of the firm's Hi-Qua-Led Steel forgings.

Also contained in the 24-page issue is an account of new quality-control measures applied at the company's thermal products division plant, details on a new land-based drilling power package in Louisiana, and a report on the operation of the SM-1 power reactor at Fort Belvoir, Va. The article on leaded-steel forgings presents physical comparisons of the new free-machining product with regular grade steels of comparable grades. —K–97

New fuel cut-out control by Reliance

Pipe one device for double protection

and add alarm for approaching low water level if desired...

Reliance Levalarm EA-100P

Using but one water chamber — one set of pipes to boiler — this new Reliance Fuel Cut-out and Alarm control gives you two efficient devices in one.

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1. Dual fuel cut-out control.
2. Float-operated fuel cut-out and electrode-operated low water level alarm.
3. Electrode-operated fuel cut-out and float-operated low water alarm.
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This Levalarm is the convenient answer in cases where two independent fuel cut-outs are required.

And this Levalarm provides outstanding additional safety to the operation of factory assembled boilers.

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NEW!
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Electric Heaters

Edwin L. Wiegand Co. offers a new bulletin, No. PD106, that illustrates its line of Chromalox cast-iron electric immersion heaters.

The heaters are designed to give fast, accurate heating for melting soft metals at temperatures up to 950 F. Presented are five popular models, available for immediate shipment, including the over-the-side mounting heaters and through-the-side heaters. **—K–98**

In-Line Reducers

Philadelphia Gear Corp. announces the availability of a catalog, MR-58, covering vertical motoreducers and in-line reducers.

Catalog MR-58 deals with motor reducers for use with equipment such as blowers, compressors, conveyors, cranes, hoists, elevators, machine tools, rotary mills, mixers, and stokers in such industries as brewing, food, lumber, oil, paper, metalworking, chemical, rubber, sewage disposal, and textile. The 28-page catalog is described as a complete selection guide. **—K–99**

Subminiature Gyros

A 62-page technical manual for subminiature rate gyroscopes has been prepared and published by Sanders Associates, Inc.

The new manual contains a description of basic principles of operation of this subminiature type gyro, operating characteristics, standard types available, transformer pickoff, and use and design of packages of one-, two-, and three-axis sensors for rate and acceleration. General application information and operating principles presented are for design use in such applications as fire control systems, autopilots, missile homing, navigation, and instrumentation. **—K–100**

Butterfly Valves

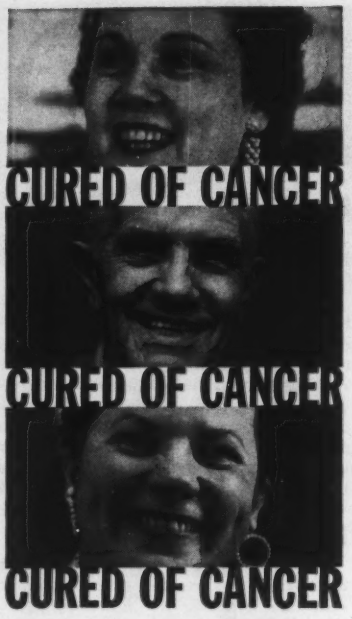
A 36-page catalog on Darling-Pelton rubber seated butterfly valves and operators has just issued by Darling Valve & Mfg. Co.

The catalog gives information on the valve design which is in accordance with American Water Works Association specifications for hydrostatic operating pressures up to 125 psi and velocities up to 16 fps. Also included is data on construction, dimensions, directions for ordering, general hydraulic data, materials and methods of operation. **—K–101**

Machine Shop Accessories

Brown & Sharpe Mfg. Co. has made available a catalog, No. 37A, on machine shop accessories.

The catalog lists arbors, adapters, collets and other machine shop accessories which the company manufactures. Features and characteristics of the products are included. **—K–102**



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AMERICAN CANCER SOCIETY

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Water-Tube Boilers

Erie City Iron Wks describes two types of its two-drum water tube factory assembled boilers in a 20-page catalog SB-57R.

The VL for any firing method is a standardized water tube steam generator that can be shipped built up or knocked down for field erection in large capacities. The VLP designates a packaged type VL with pressure tight casing for oil and/or gas firing. It may be converted to stoker firing at any later time, the firm reports. **—K–103**

Rotoblast Table-Rooms

A 12-page bulletin, No. 805, by Pangborn Corp. describes the push-button controlled LK and LM Rotoblast table-rooms designed to clean various-sized pieces ranging from small parts to castings up to 10 feet wide weighing as much as six tons.

Illustrated field reports are included, along with photographs and cut-away diagrams, dimensions and specifications. Eight table-rooms, including the new two-table type, are featured. **—K–104**

Centrifugal De-Sludgers

A bulletin describing its new line of centrifuges for recovering solids from suspensions and slurries has been issued by De Laval Separator Co.

The bulletin features photographs, specifications and dimensions of the equipment. The centrifuges, designated the NX De-Sludger line, consist of the NX 210 conical bowl; NX 211 cylindrical bowl and NX 214 combination conical and cylindrical bowl. All three types are described. **—K–105**

Demineralizers

A four-page bulletin, No. 5819, on a new line of standardized Uni-Pac packaged mixed bed demineralizers, designed specially for process water applications, is available from Cochrane Corp.

Size of the new M series mixed bed design range up to 13,200 gph. The publication contains information on the use of demineralization process eliminating variables in water and their effects on product quality control. **—K–106**

Mechanical Shaft Seals

Rotary Seal Div., Muskegon Piston Ring Co., has issued a four-page folder describing and illustrating two new designs in water pump shaft seals.

Type WPR is a self-contained, single unit seal designed for installation in original equipment production. Type WPS is a cartridge type unit seal which does not touch the shaft and is said to be unaffected by shaft speed variations and normal vibration. It is designed primarily to simplify installation on mass production lines. **—K–107**

Drip-Proof Motors

Sterling Electric Motors, Inc., announces availability of a bulletin, No. 196, on its newly developed Sterlicone multi-shielded drip-proof motors.

The bulletin illustrates five outstanding design features, and explains how these motors can replace totally-enclosed motors in many applications where adverse conditions of moisture, humidity, dust, oil, and chemicals prevail. **—K–108**

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1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
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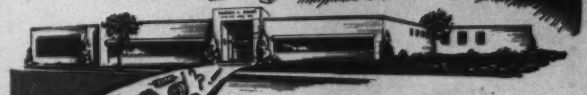

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NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Shim Gasket Selection

The 1960 edition of its ready-reference card, designed to facilitate selection of the various gages of Color-Plast shim and gasket material by color identification, has been announced by General Gasket Inc.

The material, is claimed to be completely impervious to oils and greases, even when boiling hot. It will not swell or become distorted after long use, and it will withstand high torque loads, the company reports. —K-109

Corrosion Control

Now Color Horizons is the title of a 38-page systems catalog released by the Rust-Oleum Corp.

It describes the firm's system that stops rust and provides beauty in a system of specially formulated primers and colorful top coatings. A gate-fold spread unveils 67 actual color standards in the system. Other important systems are described in detail. —K-110

Surface Condensers

Bulletin C-10, describing Type F surface condensers has been issued by the Elliott Co.

The design and construction of the condensers are described and illustrated with shop and installation photographs. Sectional drawings and photos supplement descriptions of associated process equipment and accessories—steam jet ejectors, duplex drainers, and the air leakage meter. —K-111

Fluid Filter

A two-page catalog sheet, No. 111, describing a two-micron fluid filter combination for hydraulic fluids, fuels, lubricating oils, air, gases, and solvents is available from Bendix Filter Div., Bendix Aviation Corp.

The filter combination described is Model 2670 which is designed primarily for missile/aircraft support equipment and precision industrial laboratory and process applications. The catalog sheet is illustrated with a photograph, flow rate curves and dimensional line drawings. Also included is a description and full specifications of the unit. —K-112

Control Enclosures

A 32-page catalog describes the line of hermetically sealed and protective enclosures for relays, switches, and control packages, manufactured by Automatic Electric Co.

Seventy photographs and 150 line drawings show the various housing sizes and shapes which are offered with all popular, commercially available quick-connectors. —K-113

Turbocharged Compressors

Bulletin 179 presents the turbocharged, redesigned line of HRA-T gas-engine-driven compressors manufactured by Clark Bros. Co.

Described and illustrated are the crankcase, bed section, pistons, crossheads, and running gear, all of which have been made heavier and more massive to handle the additional horsepower developed from turbocharging. Other features presented include new automatic jet-air started turbocharger, aluminum precision bearings, dry insulated manifold, high efficiency scavenging air intercooler and accessible in-line design. —K-114

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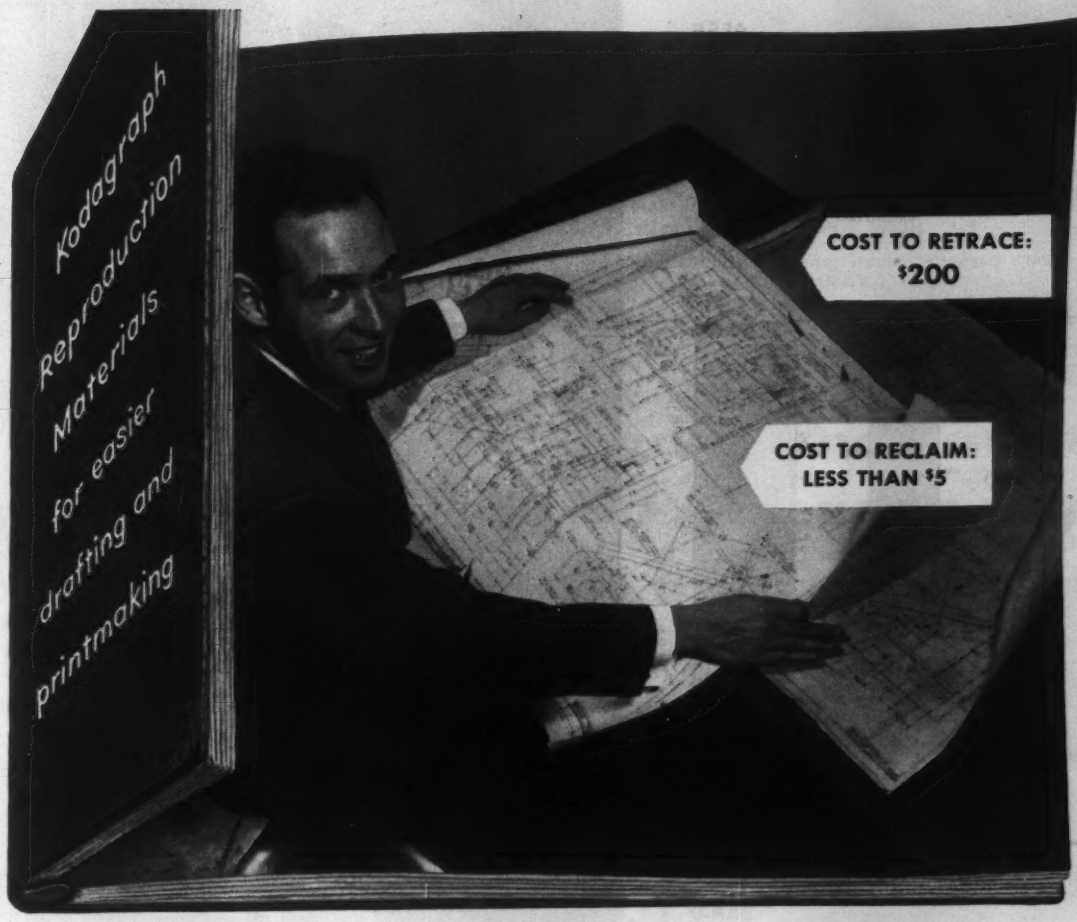

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NATIONAL REACTOR TESTING STATION
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A reactor to study the behavior of fuel elements under transient conditions
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A flexible facility for investigating boiling and nuclear superheat

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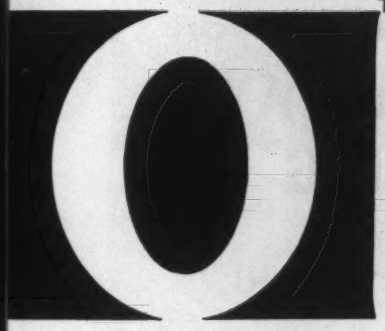
The first demonstration of breeding of nuclear fuel, proving the feasibility of producing in a reactor more fuel than is consumed during operation, (EBR-I, 1953);

The first boiling reactor, verifying the practicability of using nuclear-created steam directly in a turbogenerator system to produce electricity, (BORAX-I, 1953);

The first use of atomic power to light a town (Arco, Idaho, by BORAX-III, June, 1955).



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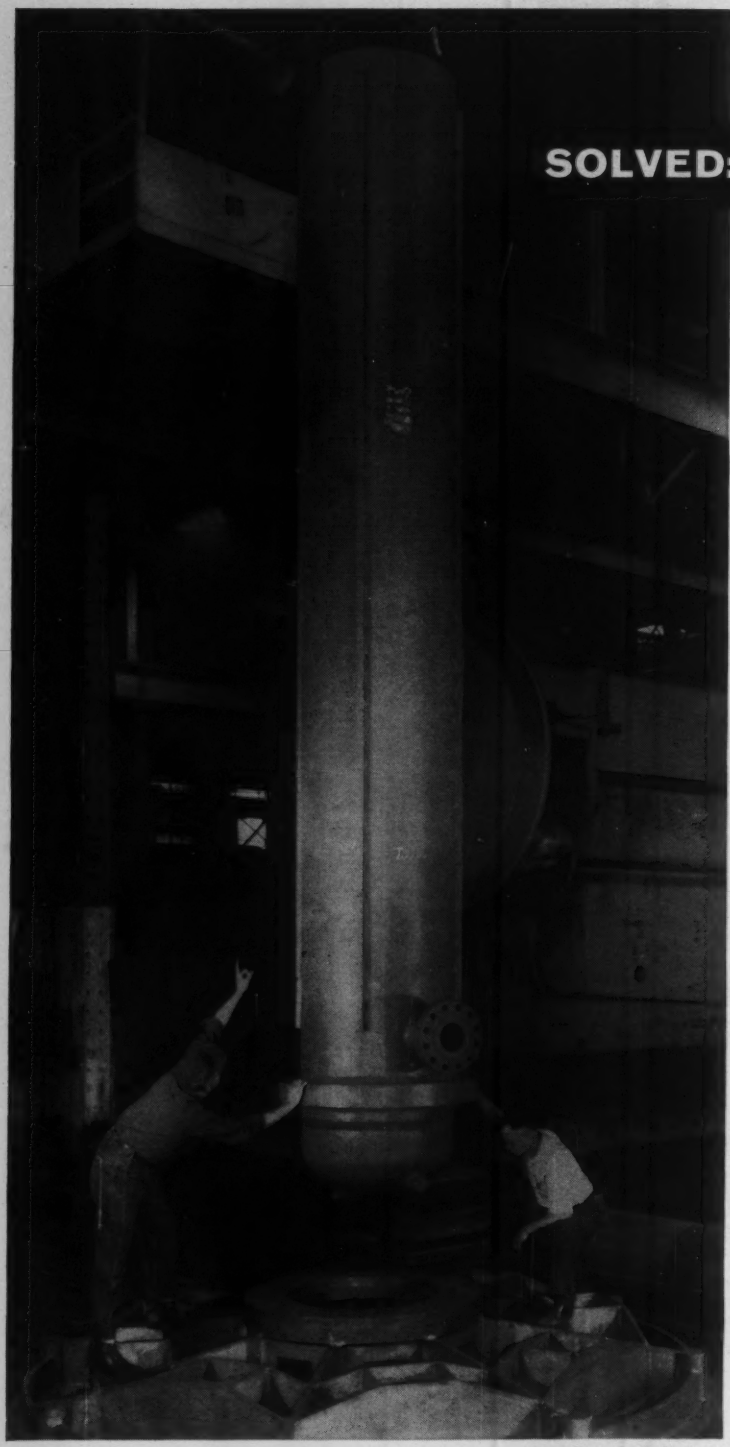

Blaw-Knox workmen assembling one of two constant pressure type accumulators built for two of America's largest steel mills. Sandusky supplied the straight cylindrical sections for both.

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Blaw-Knox chooses 10-ton

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for giant slabbing mill

When an 18½-foot cylinder was needed for a new giant Universal slabbing mill built by Blaw-Knox Company's East Chicago (Indiana) Works for a well known steel mill, they found that the most practical and economical way to meet all requirements was with a Sandusky Centrifugal Casting.

This 10-ton carbon steel cylinder, 32" O.D. with a 3½" wall, functions as an accumulator in the mill's hydraulic roll balancing system. Essentially a pressure vessel, it simultaneously supports the ram and ballast weighing 226 tons—the weight required to develop constant operating pressure of 1000 p.s.i.

"Only a dimensionally stable, one-piece cylinder could perform satisfactorily in this service," a Blaw-Knox official asserted. *"Distortion could lead to binding, loss of pressure and costly downtime. Sandusky's ability to produce this heavy walled cylinder in one 18½ foot length met all our requirements of cost, stability, and strength."*

Sandusky cylinders up to 33 feet long —from 7" to 54" O.D.— and in a wide range of ferrous and non-ferrous alloys —may well be the answer to *your cylindrical problems,* too.

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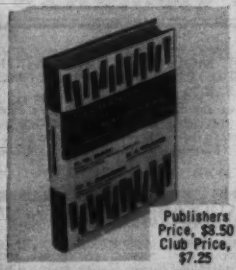

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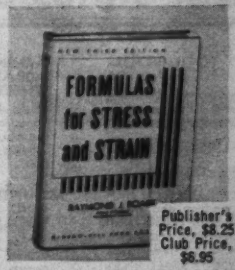

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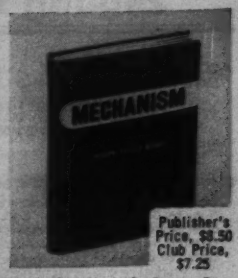

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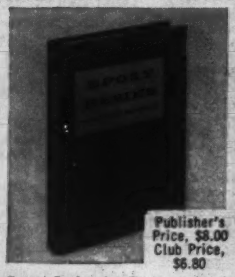

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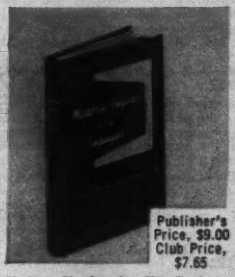

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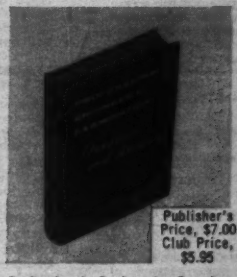

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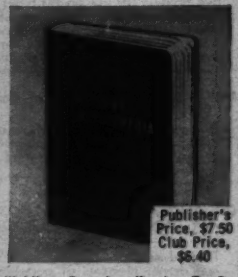

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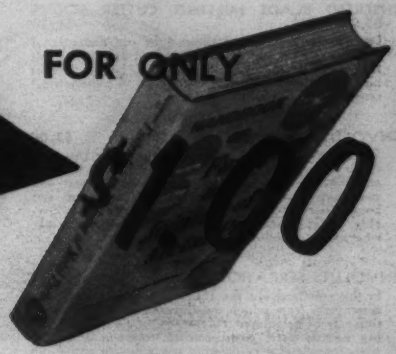

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MEN-2-60

Here are the AMERICAN STANDARDS to consult—
for approved dimensions, permissible tolerances, and other specifications covering SMALL TOOLS AND MACHINE TOOL ELEMENTS

ACCURACY OF ENGINE AND TOOL ROOM LATHES, B5.16—1952. $1.00
Gives the tolerances to which industry is building 12 in. to 18 in., 20 in. to 32 in., and 40 in. to 72 in. lathes and the tests for determining the accuracy of the lathes.

CHUCKS AND CHUCK JAWS, B5.8—1954. $1.50
Establishes controlling dimensions for all chucks from 6-in. to 36-in. diameter of both medium and heavy duty types, for an extra heavy series of chucks with serrated master jaws, for power-operated and hand-operated chucks of two-, three-, and four-jaw types.

CIRCULAR AND DOVETAILED FORMING TOOL BLANKS, B5.7—1954. $1.50
In this standard are the sizes and types of tool blanks and the associated mounting portions of their respective holders for use on 60 types of automatic screw machines, the latter being classified in the standard into six different groups of comparable stock capacities. Tolerances and screw threads are specified. Typical blanks and holders are illustrated.

DRILL DRIVERS (Split-Sleeve, Collet-Type), B5.27—1959. $1.50
This standard gives taper dimensions, general specifications, and the dimensions for 151 sizes of drill drivers along with the standard and optional taper number for each size.

DRIVING AND SPINDLE ENDS FOR PORTABLE AIR AND ELECTRIC TOOLS, B5.38—1958. $1.50
These dimensions and tolerances are for both driving and driven elements of portable powered tools of either air or electric type. Also covered are threaded spindles for geared chucks and abrasion tools, Jacobs tapers and hexagonal and square drives.

INSERTED BLADE MILLING CUTTER BODIES B5.23—1958. $1.50
In this standard are the dimensions and dimensional tolerances of cutter bodies for shell end mills, half side mills, staggered-tooth side mills, face mills—flat back series, and face mills—series 50 in a diametrical range of 3 to 24 in.

INVOLUTE SPLINES, B5.15—1950. $3.00
Tables give dimensional and effective clearances, minor diameter fits, dimensions for both the flat root and fillet root types, basic measurements between and over pins, special pin measurements and hob and broach dimensions. Provisions are made for allowable errors. Formulas are given for calculating pin measurements and torque capacities.

INVOLUTE SERRATIONS, B5.26—1950. $2.00
In this standard are the tooth dimensions, the basic dimensions from which the dimensions for any serration may be calculated, tolerances for a complete gaging system, basic measurements between and over pins, formulas for calculating space width and tooth thicknesses, recommended hob dimensions, and provisions for allowable deviations.

INVOLUTE SPLINE AND SERRATION GAGES AND GAGING, B5.31—1953. $1.50
Factors affecting fits and their control, working and inspection gages, inspection methods, machining tolerances and allowable errors are among the subjects covered.

JIG BUSHINGS, B5.6—1941. (Reaffirmed 1949) $1.00
Dimensions for: Press-Fit Wearing, Renewable-Wearing and Liner Bushings.

KNURLING, B5.30—1958. $1.50
This standard specifies dimensional relationship between the knurling tool and stock and gives standard diametrical pitches for tools.

MACHINE MOUNTING SPECIFICATIONS FOR ABRASIVE DISCS AND PLATE MOUNTED WHEELS, B.35—1957. $1.50
Establishes standards for location and size of bolt holes in steel disc wheels (machine face plates) and the mounting side of abrasive discs and plate mounted wheels. Twenty-seven illustrations supplement the text.

MOUNTING DIMENSIONS OF LUBRICATING AND COOLANT PUMPS FOR MACHINE TOOLS, B5.28—1958. $1.00
Tables give specific mounting dimensions for motor-driven centrifugal pumps, centrifugal and geared pumps, centrifugal pumps (flange mounted type), gear and vane pumps, and for mounting brackets.

PUNCH AND DIE SETS FOR TWO-POST PUNCH PRESS TOOLS, B5.25—1950. $1.50
These dimensions for back-post and diagonal-post sets cover die area, the die holder and punch holder thickness, shank diameter and lengths, guideposts and bushings, and removable punch holder shanks.

ROTATING AIR CYLINDERS AND ADAPTERS, B5.5—1959. $1.00
Here are given the dimensions of ten sizes of air cylinders; the pull and stress data at 100 lb. square inch air pressure; the dimensions of four sizes of adapters; the sizes of adapter screws and tapped holes.
In this 1959 Revision the method of dimensioning radial hole locations has been changed and a number of revisions have been made in the dimensional tables to permit design of lighter and shorter cylinders.

CARBIDE BLANKS AND CUTTING TOOLS, B5.36—1957. $2.00
Gives the sizes, styles, designations, dimensions and tolerances of eight styles of sintered carbide blanks; tipped tools with square or rectangular shanks; boring tools and tool bits; and inserts $1^1/_2$" long and their holders.

HIGH SPEED STEEL AND CAST NONFERROUS SINGLE POINT TOOLS AND TOOL HOLDERS, B5.29—1959. $1.00
The tools for which sizes and tolerances are given in this standard are those in common usage for general purpose machine. Additionally the standard gives the nominal shank sizes of tool bit holders.

MARKINGS FOR GRINDING WHEELS, B5.17—1958. $1.00
Covering markings only, this standard establishes a symbol for each of the most essential characteristics of a grinding wheel and arranges them in uniform sequence.

SPINDLE NOSES FOR TOOL ROOM LATHES, ENGINE LATHES, TURRET LATHES, AND AUTOMATIC LATHES, B5.9—1954. $2.50
Presents dimensions of each size and type of nose of mating backs of chucks, face plates and fixtures, and of gages for checking their important dimensions. Permissible tolerances are specified.

SPINDLE NOSES AND ADJUSTABLE ADAPTERS FOR MULTIPLE SPINDLE DRILLING HEADS, B5.11—1954. $1.00
Here are the general dimensions of assembly and the detail dimensions of adjustable adapter body, set screw slot, adjustable extension adapters, adjustable adapter set screw and friction lock nuts, and spindle noses. Tolerances, finish and marking are specified.

SPINDLE NOSES AND ARBORS FOR MILLING MACHINES, B5.18—1953. $1.00
Contains dimensions for ends of arbor and adapter, for spindle nose, and for draw-in bolt end; also sketches of selective types of drive key construction.

STRAIGHT CUT-OFF BLADES FOR LATHES AND SCREW MACHINES, B5.21—1949. $1.00
Gives dimensions for the height, length, and thickness of the approved four types of blades, and includes sketches to show the optional shapes for cut-off blade stock.

T-SLOTS, THEIR BOLTS, NUTS, TONGUES, AND CUTTERS, B5.1—1949. $1.50
Tables show dimensions for T-slot, their tongues and cutters; and for inserted and reversible tongues and tongue seats. Tolerances are specified.

LIFE TESTS OF SINGLE-POINT TOOLS, B5.19—1946. (Reaffirmed 1953) $1.00
Shows how to evaluate performance of single-point tools made of material other than sintered carbides.

LIFE TESTS FOR SINGLE-POINT TOOLS OF SINTERED CARBIDE, B5.34—1956. $1.00
This test procedure for determining tool life covers grade, shape and size of tool, material to be machined, the shape and size of cut, the cutting fluid, and relationship between tool wear and cutting time.

TWIST DRILLS, B5.12—1958. $2.00
Included in this standard are nomenclature, definitions, sizes and tolerances of two flute straight and tapered shank twist drills, combined drills and countersinks, selected sizes of millimeter drills, screw machine length drills, jobbers length and taper length drills. Drill sizes and their decimal equivalents are also listed.

DESIGNATION AND WORKING RANGES OF GRINDING MACHINES, B5.32 and 33—1953. $1.00
Data and information supplied by this standard apply to all sizes of reciprocating table surface grinders having horizontal spindles and to all swings of plain cylindrical grinding machines up to and including 36 in. size.

MACHINE TAPERS, B5.10—1953. $1.50
Presents basic dimensions for 22 sizes of self-holding tapers; detailed dimensions and tolerances for self-holding taper shanks and sockets, for the plug and ring gages applying to this series of tapers; and the dimensions for 12 sizes of steep machine tapers

MACHINE PINS, B5.20—1958. $1.50
These dimensions are for hardened and ground dowel pins, straight pins, ground dowel pins (not hardened), taper pins, clevis pins, and cotter pins. An appendix gives drilling specifications for taper pins and a drill chart for the size of drill and number required.

MILLING CUTTERS, B5.3—1950. $3.00
Gives the dimensions and illustrations of fifty-six types of milling cutters.

REAMERS, B5.14—1959. $2.50
Following a comprehensive glossary of reamer terms, tolerances and general dimensions are given for thirty-seven types of reamers. New additions to this document are the dimensions for an extended series of high speed steel straight shank reamers and the revised nomenclature.

TAPS—CUT AND GROUND THREADS, B5.4—1959. $2.50
It describes the various tap styles, has a greatly expanded section on nomenclature and definitions, and presents complete specifications of the standard taps, including new styles such as oversize machine screw taps, helical flute taps, and spiral point taps with short flutes. It also lists the tap recommendations for all classes of Unified and American screw threads.

BINDERS

A specially designed binder for holding these standards is available. It is 9" × 12" in size and provided with flexible steel rods which can be slipped out of or under the top and bottom metal lips. It gives every advantage of a bound book together with the added convenience which comes from the ability to instantly insert, remove or transpose sections of the contents. **Price, $3.25**

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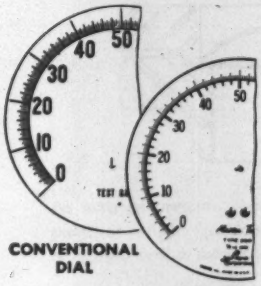
of extremely accurate test gauges



Crowning achievement in instrument making... this superb series of test gauges developed to meet today's exacting requirements of instrument men throughout industry. Accuracy and dependability beyond compare...each gauge individually dead-weight tested (think what that means!)...each gauge guaranteed accurate within ¼ of 1% plus or minus of the maximum dial reading over the entire range.

To provide reading accuracy in keeping with the accuracy of the instrument, all "Master-test" gauges have the simplified "Read-easy" dial (patent pending) illustrated opposite—a dial that can be read with the accuracy of a caliper, yet with the ease of a clock.

To further increase accuracy, three advanced means of reading have been developed as described below: the "twin-tip" pointer; the mirror path; the non-parallax dial.

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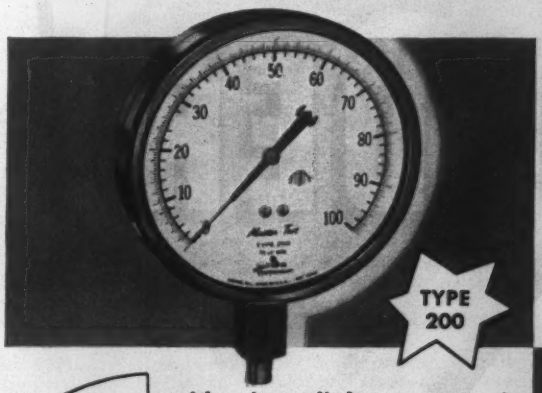
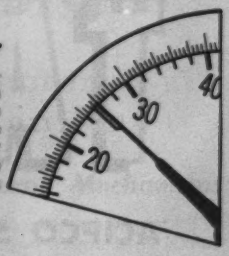
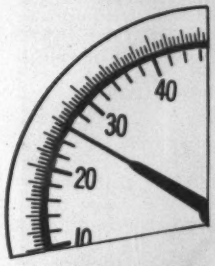


← with "Twin-tip" pointer

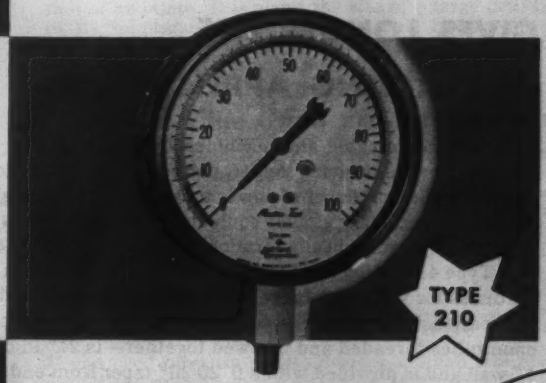
The most common error in reading pressure occurs when the observer reads from an angle rather than "dead on". This Marsh "Twin-tip" pointer enables the operator to know when he is dead on by lining up the two tips so that only one is visible. The twin-point arrangement is similar to the sights on a rifle.





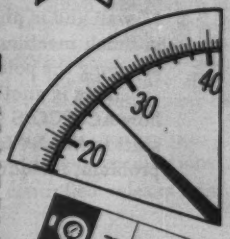
with mirror dial →

Another method of insuring accurate "dead on" reading. Knife edge pointer is reflected by the mirror path. When reflection is not seen, reading is dead on and true. The ease and accuracy with which the mirror dial may be read cannot be duplicated by any other mirror type dial. It is the combining of the mirror path with the exclusive Marsh "Read-easy" dial that makes this faster, error-free reading possible.



← with "Non-parallax" dial

This Marsh development eliminates mistakes in dial reading even if read at an angle. To accomplish it Marsh engineers designed a clear Plexiglas insert placed, as shown, over the fine graduations so that they appear to be at the same level as the pointer regardless of the viewing angle. The "Non-parallax" dial provides the easiest and most accurate dial reading available.



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ACIPCO 50-FT. MANDREL GIVES LONGER LIFE IN EXACTING APPLICATION

Completely fabricated and machined by ACIPCO, this 50-foot mandrel is giving longer, more durable service to an outstanding producer of power transmission poles, light standards, and other similar equipment. These products are produced by hydraulically forming steel plate around the mandrel.

Type 4330 alloy steel, heat treated to 300 minimum Brinell hardness for wear resistance and strength, was selected for this application. The mandrel—consisting of four ACIPCO centrifugally spun tubes threaded and screwed together—is 24″ in diameter with a 3″ wall and is provided with a 0°20′20″ taper from end to end. The O. D. is finish machined and belt polished to a 125 micro-inch finish to facilitate stripping the poles from the mandrel.

This is another example of ACIPCO versatility in action . . . of how ACIPCO'S wide range of sizes and analyses, and "one source—from start to finish" facilities can solve a complicated steel tubing problem, including YOURS!

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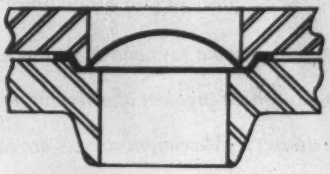
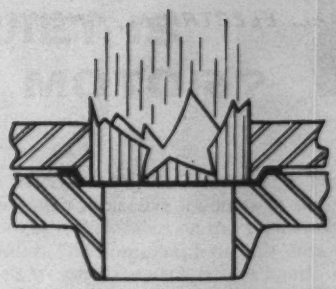


As long as pressure remains below the pre-determined point at which the dome-shaped disc will rupture, a leak tight seal is maintained.



When pressure attains the rated rupture point of the disc, instant release is provided through full orifice diameter by the outward bursting of the rupture disc.

An Advanced Approach To Pressure Systems Design

How To Reduce Weight Factor In Pressure Release Mechanisms

Although BS&B Safety Heads, in one form or another, have been providing over-pressure protection for closed pressure systems in numerous industries for more than 25 years, it is only recently that they have come into their own as pressure release devices for various types of airborne equipment.

Recent metallurgical and engineering developments, as well as improved manufacturing procedures, have made the BS&B Safety Head today's lightest weight, most accurately calibrated pressure release device ever developed. A typical Safety Head consists of a metal rupture membrane secured in mounting flanges. There are no moving parts.

Weakness A Virtue

The rupture membrane, or disc, is a purposely designed "weak spot" in the pressure system. Over-pressure bursts it at a pre-determined set pressure rating.

Full relief area is achieved instantly. When the disc ruptures a full throated opening is provided. This outstanding feature is most advantageous in pressured systems where ignition or exothermic reaction during a process causes abnormal pressure rise in seconds or milliseconds.

... This briefly, is the function of a BS&B Safety Head as related to over-pressure protection.

Imagination The Only Limiting Factor

The application and design of Safety Heads is continually being expanded. BS&B Safety Heads are serving the aircraft and missiles industries in ground, air and marine applications.

As an example ... visualize the rupture disc as a seal to retain pressure in a chamber, and actuated (burst) by pressure developed within seconds or milliseconds. The pressurized fluid is thus discharged into another chamber. Here ignition may take place with contact of another fuel component. Chemical reaction may instead serve to further energize the system.

As a different application of the same basic device, the rupture disc of a Safety Head could serve as a signaling device ... or to retain pressure to a pre-determined point whereupon it would then be actuated by an explosive squib or primacord.

Peculiarly Suited To Airborne Mechanisms

Weight is of prime concern in airborne equipment. The smallest Safety Head now in production weighs only a fraction of an ounce. It is about the size of a large pea. In spite of its minuscule specifications it still retains all of the design features and precise operating characteristics so essential to satisfactory performance.

Big Or Little, High Pressure Or Low

BS&B Safety Head sizes range from ⅛" to 44" in exposed diameter of the rupture disc. Pressure rating for the disc can be anywhere from 5 psi. to 100,000 psi. Mounting flanges and rupture disc metals can be varied over a wide selection to accommodate exposure to acids or other corrosive conditions as well as to elevated and sub-zero temperatures.

Hundreds Of Design Variations Possible

If you need pressure release devices of small size and light weight for missiles and JATOS, or large sizes for ground fueling systems and engine test facilities, you should examine the advantages of using BS&B Safety Heads. Chances are there is a Safety Head of the necessary characteristics available from present designs. If not, it can be custom built to your specifications.

Here then are just a few of the reasons why BS&B Safety Heads can serve you better in many different applications...

- A pressure relief device with controlled release accuracy.
- Leak tight.
- Light weight.
- No movable parts.

For answers to your specific questions contact the Safety Head Division at the General Offices in Kansas City, or the BS&B Field Sales Office or Sales Agent located nearest you.

BLACK, SIVALLS & BRYSON, INC., Safety Head Division, Dept. 2-FQ2
7500 E. 12th Street, Kansas City 26, Missouri

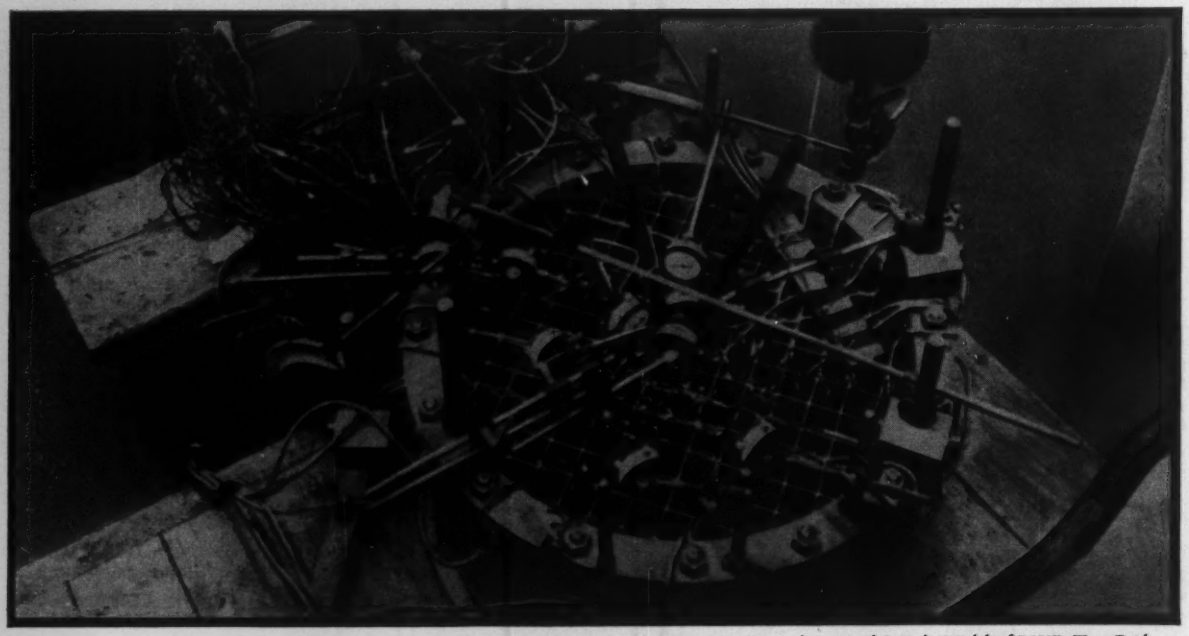
MECHANICAL, ELECTRICAL, CHEMICAL ENGINEERS

Investigate

Evaluating the adequacy of grid design when the grid is unevenly heated by gamma rays and subject to hydraulic loads, is basically a problem of determining thermal and mechanical stresses... Maximum stresses are calculated for a solid plate with basic modifications in the equations, such as setting Poisson's ratio to zero and solving compatibility equations between the ring and grid.

GAMMA RAY HEATING

If you are a mechanical, electrical or chemical engineer interested in a career in nuclear engineering and are a U.S. Citizen, Bettis Atomic Power Laboratory offers a dynamic program in nuclear system design and test. For additional information, write to: Mr. M. J. Downey, Dept. B-29, Bettis Atomic Power Laboratory, Westinghouse Electric Corporation, P.O. Box 1526, Pittsburgh 30, Pa.

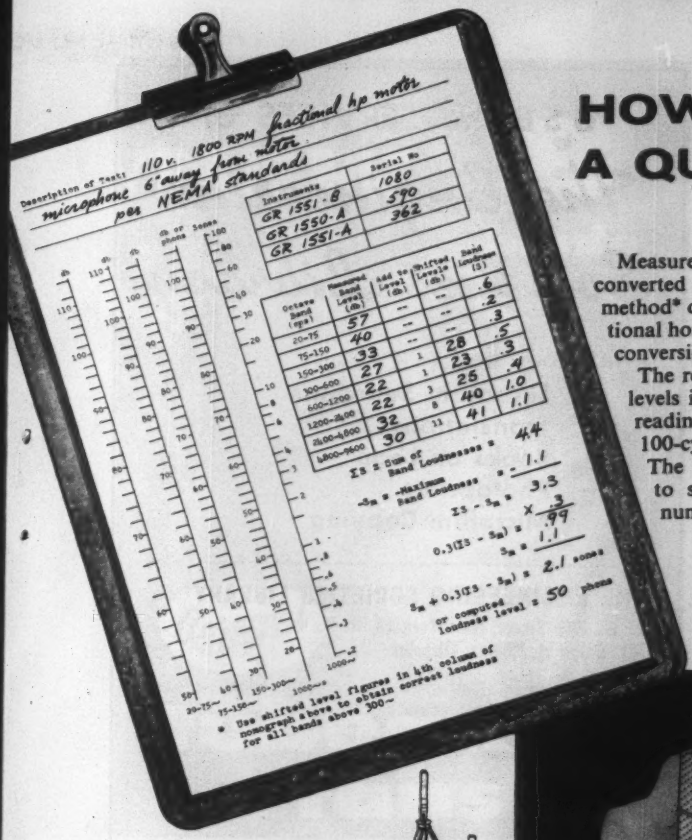


Strain Gages shown on ¼ Scale Model of PWR Top Grid

BETTIS ATOMIC POWER LABORATORY

Westinghouse

HOW QUIET IS A QUIET MOTOR?


Description of Tests: 110 v. 1800 RPM fractional hp motor
microphone 6" away from motor
per NEMA standards
Instruments
GR 1551-B
GR 1550-A
GR 1551-A
Serial No
1080
570
362
Octave Band (cps)
Measured Band Level (db)
Add to Level (db)
Shifted Level (db)
Band Loudness (S)
20-75 57 -- -- .6
75-150 40 -- -- .2
150-300 33 -- -- .3
300-600 27 1 28 .5
600-1200 22 3 25 .3
1200-2400 22 8 40 .4
2400-4800 32 13 41 1.0
4800-9600 30 11 41 1.1
ΣS = Sum of Band Loudnesses = 4.4
-Sm = -Maximum Band Loudness = -1.1
ΣS - Sm = 3.3
0.3(ΣS - Sm) = x .3
.99
Sm = 1.1
St = Sm + 0.3(ΣS - Sm) = 2.1 sones
or computed loudness level = 50 phons
* Use shifted level figures in 4th column of nomograph above to obtain correct loudness for all bands above 300~

Measurements with the G-R 1550-A Octave-Band Noise Analyzer can be converted to an approximate subjective loudness in sones using the Stevens method* of calculation, as is illustrated on the typical data sheet for a fractional horsepower motor. The nomograph on this data sheet permits direct conversion of decibels to sones for each octave band.

The results of these calculations are more valuable than sound-pressure levels in specifying product noise, since sounds producing equal decibel readings do not always *sound* as though they are equal, i.e., an 80-db 100-cycle tone does not sound as loud as an 80-db broad-band noise. The Stevens method avoids such difficulties by converting db levels to sones, thereby permitting a means of specifying loudness in a numerical language that is more closely related to hearing.

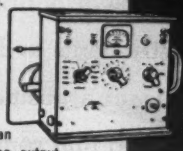
*S. S. Stevens, "The Calculation of the Loudness of Complex Noise," Journal of the Acoustical Society, September, 1956, states that loudness in octave bands can be combined by the formula: $S_t = S_m + 0.3\,(\Sigma S - S_m)$, where S_t is total loudness in sones, S_m is the loudness of the loudest band, ΣS is the sum of the loudnesses of all the bands. Also see S. S. Stevens, "The Measurement of Loudness," Journal of the Acoustical Society, September, 1955; and S. S. Stevens, "Calculating Loudness," Noise Control, September, 1957.

Type 1551-P1H and 1551-P1L Condenser Microphone Systems, $340 for either

. . . consist of a preamplifier, power supply, 10-foot cable, tripod, and a leather carrying case. Frequency response is 20c to 18 kc. Type 1551-P1L measures sound pressure levels up to 155 db; Type 1551-P1H range extends to 170 db.

Type 1551-B Sound-Level Meter, $395

. . . consists essentially of a non-directional microphone, calibrated attenuator, amplifier, weighting networks, and an indicating meter. Range is 24 to 150 db. Equipped with crystal microphone whose frequency response is 20c to 8 kc. Amplifier frequency response is 20c to 20 kc for use with auxiliary microphones. Battery-powered. Can be used with a wide variety of noise and vibration analyzers. Meets ASA standards for sound-level meters.



Type 1550-A Octave-Band Analyzer, $535

. . . consists of eight band-pass filters, each of whose ultimate rejection is over 60 db; an attenuator; and an amplifier, which operates an indicating meter and supplies a monitoring output. Frequency range — 20 to 10,000 cycles in 8 selectable bands. Excellent attenuation characteristics — slope at cutoff points is better than 45-db per octave for middle bands.

In test laboratories of a typical ball-bearing manufacturer, General Radio Sound-Measuring equipment is used for electric-motor noise investigations, particularly to determine effects of ball-bearing assemblies and mounting methods. Because small-motor noise is often high pitched, a condenser microphone capable of measuring the higher audible frequencies is used. The Octave-Band Noise Analyzer shown operating from the Sound-Level Meter determines the noise spectrum produced by the motor.

Write for G-R Sound Bulletin for Complete Information

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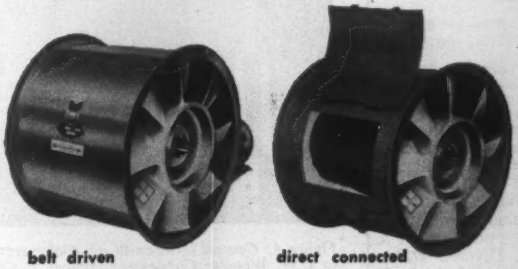
tubeaxial fans

high speed - high efficiency

Aerovent's new Tubeaxial Fan, designed around a new 8-blade "Macheta" Airfoil Axial Flow Propeller, offers top performance against medium pressures at speeds to 3450 RPM. Available in 16", 18", 24", and 30" diameters, this unit combines speed, stamina and modern functional design. Easily installed in present ductwork or engineered to new construction, it's the right answer for resistances to 4" SP. Another outstanding development from Aerovent—America's finest industrial fans and air equipment.



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1 Must not permit water to be transmitted across the cavity.
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3 Must retain its insulating efficiency in actual field conditions.

Actual building has shown, too, that *Zonolite Water-Repellent Masonry Fill Insulation* cuts masonry wall insulation costs over 60%...reduces heat transfer through walls as much as one-half...cuts air-conditioning costs as much as 25%. Send today for official reports substantiating these statements. No cost or obligation. . .just mail the coupon.

MAIL COUPON FOR LABORATORY TEST DATA

ZONOLITE COMPANY, Dept. ME-20, 135 S. La Salle St., Chicago 3, Ill.
Rush me complete information and test data on Zonolite Water-Repellent Masonry Fill Insulation.

Name_____

Company_____

Address_____

City & Zone_____ State_____

TRIPLE LANE TUBE LAYOUT . . .

what it is and how it IMPROVES CONDENSER OPERATING EFFICIENCY

An informative advertisement from one of the nation's most experienced condenser manufacturers

Steam condenser efficiency depends on water temperature and condition, proper maintenance procedures and many other factors. One of the most important is the design of the condenser itself—and *this* is largely a function of tube sheet design.

Triple Lane Tube Layout, a development of C.H. Wheeler Manufacturing Company of Philadelphia, is making significant contributions to condenser operating efficiencies in public utilities and industrial plants throughout the country. Figure 1 shows a C.H. Wheeler Dual Bank Surface Condenser with Triple Lane Tube Layout.

This tube sheet design permits steam to travel through three separate pathways. As a consequence steam penetrates to all condensing surfaces and utilizes to the fullest extent the condensing capabilities of the steam condenser.

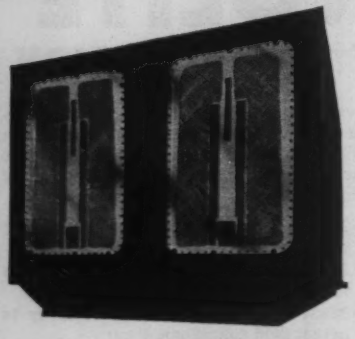

Figure 1: Typical C.H. Wheeler Condenser with Triple Lane Tube Layout.

Central location of the air cooler section, another C.H. Wheeler design feature, also improves steam travel. It reduces the depth of steam penetration and therefore reduces resistance to steam passage, achieving a new low in condenser pressure loss.

How Reverse Flow Improves Condenser Efficiency, Reduces Maintenance

Proper maintenance—keeping tubes and tube sheets free from foreign matter, algae and scale—helps keep condensers operating at peak efficiency. In some cases grass and twigs build up to a point where they would ordinarily have to be shoveled out! It is in such cases that C.H. Wheeler Reverse Flow solves time-consuming, expensive maintenance problems. Here's how it works:

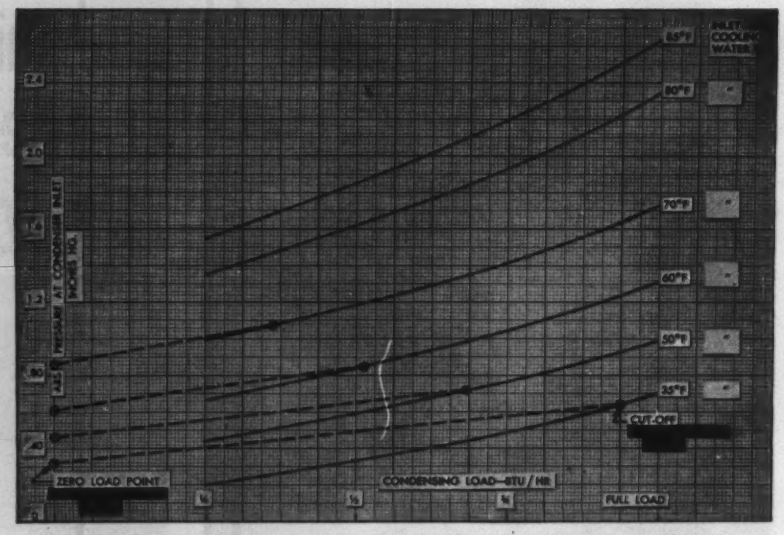

Figure 2: Typical condenser performance curves show how inlet cooling water temperature affects absolute pressure at condenser inlet at varying condensing loads. For a complimentary copy of the 38-page Condenser Handbook from which these curves are taken, write to C.H. Wheeler on your company letterhead.

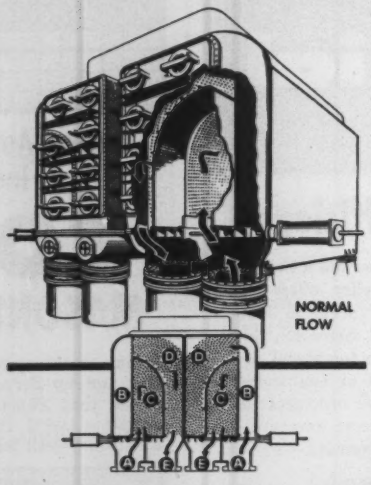

Figure 3: Diagram of C.H. Wheeler Reverse Flow which cleans tubes and sheets during full load operation.

Normal operation is shown on the left in the diagram in Figure 3. Water enters through inlet A with inside port open, flows through tube bank C to the rear of the condenser. It returns through tube bank D to the front of the condenser and discharges at E.

The right side of the diagram in Figure 3 shows Reverse Flow in operation in a C.H. Wheeler Dual Bank, Divided Water Box Condenser. Water enters through A with outside port open, flows up through channel B and through tube bank D to rear of condenser, returns through tube bank C to front of condenser and discharges at E.

Reversing can be accomplished during full load operation and full flow of circulating water, without additional pressure loss. Sluice gates for each half of the condenser move on a common stem. Each half of the condenser can be back-flushed independently; or both halves can be back-flushed simultaneously with one or two circulating pumps operating.

Because of more-than-half-a-century of experience in condenser design and maintenance, C.H. Wheeler is unusually well qualified to advise on condenser efficiency and maintenance problems. We invite your inquiry, whether you're concerned with condensers or with circulating and condensate pumps and other auxiliary equipment. A note on your company letterhead will receive prompt attention from us.

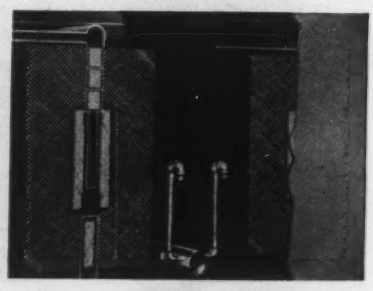

Figure 4: Central location of air cooler section in C.H. Wheeler Condensers reduces depth of steam penetration and therefore lessens resistance to steam passage, achieving a new low in pressure loss in the condenser.

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Please send resume of experience, including salary information, to Professional Employment Manager.

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Assignments involve maintenance of existing equipment at optimum operating efficiency as well as the construction of new installations prepared by the design engineering group.

Up to 8 years' experience in either area desirable.

All replies confidential. Please send resume to:

Manager, Technical Employment
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To initiate formal Quality Control function for propellant manufacture, mechanical parts and all other aspects of rocket development and production.
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To take first line responsibility for supervision of craftsmen and maintenance of solid propellant production and test facility in rural Virginia. The skills involved include pipe fitting, welding, electrical and some machine shop work.
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M.S., mechanical or chemical engineering, with thorough knowledge of all phases of heat transmission.

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To direct, conduct physical test program and correlate test data on physical characteristics of propellant bonding systems, inhibitors and other materials used in solid propellant rocket motors.
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These new positions created by the progressive expansion of our contract R & D organization represent a few of the "key spots" now available to capable technical men who have demonstrated accomplishments in their respective fields.

Atlantic Research Corporation has just completed eleven years of steady and fruitful growth in research and development for government and industry. Substantial contributions to the solid propellant rocket, chemical, mechanical and electronic fields, have led us into manufacture and sales of several products. Present staff, including affiliates, now numbers approximately 1000 and the annual business volume is in excess of 10 million dollars.

If your academic training and experience appears to fit any of the above positions, or you would like to explore other possibilities within the Company, please send resume of career experience, academic background, age, salary desires and professional references to:

Clarence H. Weissenstein, Director, Technical Personnel Recruitment
Atlantic Research Corporation, Alexandria, Virginia ME 250

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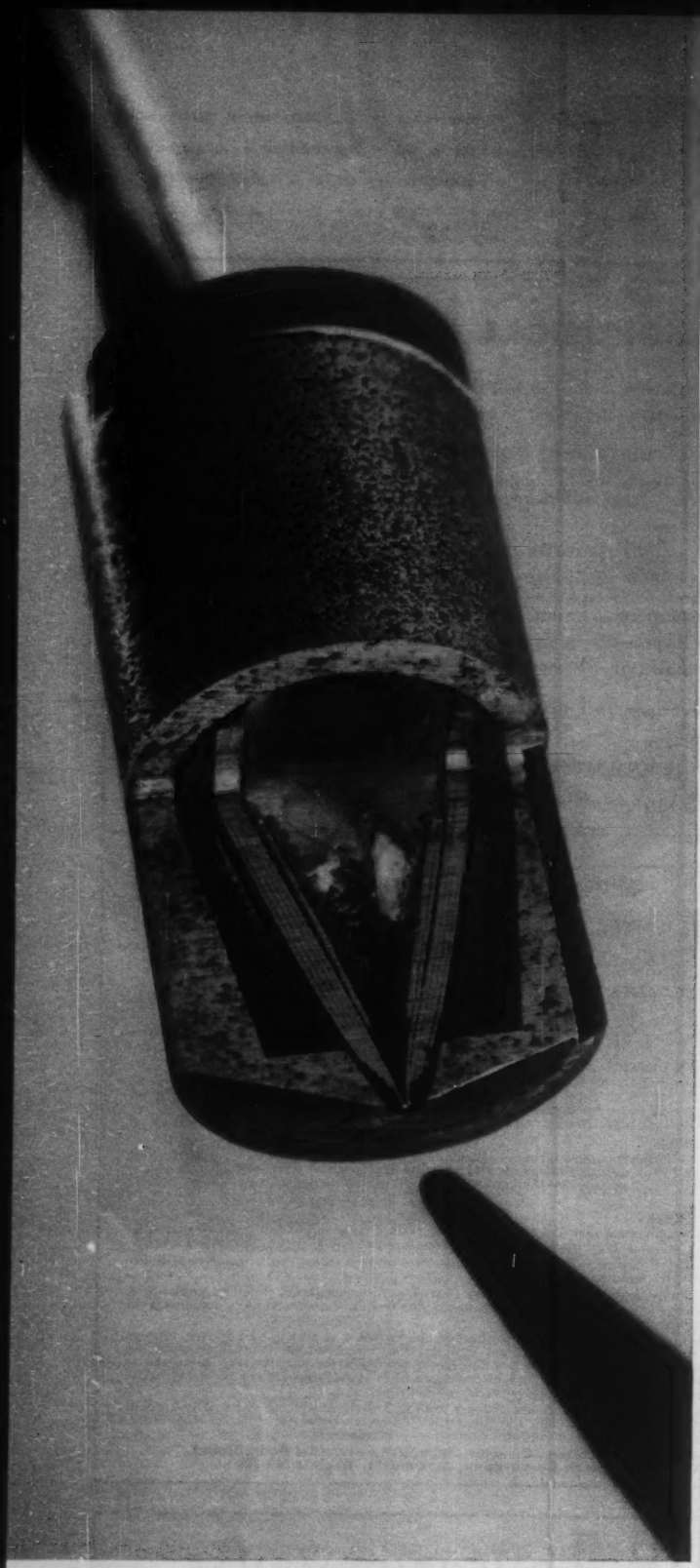

This high-resolution magnetic drum head, recently developed by IBM engineers, has made possible greatly expanded storage capacities for systems such as the 650 computer.

Opportunities in systems development

Expanding Computer Memory to Hold One Million Bits of Information

Some time ago IBM scientists were handed a knotty problem: how to develop a magnetic drum memory (for a system similar to the 650 computer) that retains present speeds and access time but multiplies storage capacity.

Starting with the existing system—operated at 125 kc., 50 bits per inch, and 20 tracks per inch—the engineers aimed at a memory of 500 kc., 200 bits per inch, and 40 tracks per inch. After months of work, they achieved their goal with advanced transistor circuitry and an improved read-write head which affords greater bit and track densities.

The result: Drum capacity has been expanded *eight times* to an unprecedented one million bits.

Although this accomplishment satisfies an immediate need, work is in progress to develop magnetic memories of even superior capabilities. Several positions are available on the development team assigned to this project. In addition, interesting opportunities exist on projects involving microwaves, optics, semiconductors, inertial guidance, and human factors engineering.

If you have experience in these fields and a degree in engineering, mathematics, or one of the sciences, you may find the career you've been looking for in IBM systems development. For more information, write—outlining your background and interests—to:

Manager of Technical Employment, Dept. 598N
IBM Corporation
590 Madison Avenue, New York 22, N.Y.

FEB. 21-27 1960

IBM INTERNATIONAL BUSINESS MACHINES CORPORATION

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With PhD in Mechanical Engineering and varied interests to originate mechanisms and process equipment. Ideal spot for type desiring to achieve success through personal initiative. Write, giving details of educational background and prior work experience, to:

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January, 1960 CARD INDEX Vol. 82, No. 1

Developing Managerial Abilities, F. F. Bradshaw 29
The Nation's Water Resources 31
Industrial Water, E. P. Partridge; Water Management, K. S. Watson; Ground Water, J. G. Ferris; Water Wells, Paul Weaver; Creating Storage, G. H. Higgins
The 2000 Hour Proteus Turboprop, P. F. Green 37
Feedback—Consumer to Factory, R. E. McGarrah 41
Steam-Turbine Buckets—Automatically Milled, R. H. Wilke and Abdon Rubio 44
Engineering Application of Digital Computers, H. D. Irwin 48
1959 ASME Annual Meeting Report 76
ASME Honors Engineer 104
Woman's Auxiliary to the ASME 111
Availability List—Annual Meeting Papers 114
Engineer 25
Editorial 27
Briefing the Record 51
Photo Briefs 62
European Survey 64
ASME Technical Digest 66
Comments on Papers 118
Books Received in Library 118
ASME Boiler and Pressure Vessel Code 119
The Roundup 122
The ASME News 127

Mechanical Engineers

Openings at AMF

Springdale, Conn.

An expanding division of American Machine & Foundry Company is forming an outstanding team in the new Mechanical Engineering Laboratory at Springdale, Connecticut. The fast-growing new Research & Development Division offers a tremendous latitude for imaginative thinking—covering the widest technical spectrum in Commercial Development. There are openings for Mechanical Engineers in the following areas:

AUTOMATIC MACHINERY

M/ME or equivalent with minimum 7 years' experience in the design and development of automatic machinery. Will direct complete projects from the original concept stage up through fabrication and testing, including coordination of associated research and preparation of specifications, studies and technical reports.

HYDRAULICS AND FLUID FLOW

Degree engineer with 7–10 years in the design and development of fluid flow, hydraulics, and pneumatic equipment. Must be imaginative with a well-developed ability to conceptualize.

MECHANISMS

M/ME with 5–7 years' or BS/ME with 10 years' experience in the field of small mechanisms, automatic mechanical apparatus, and electromechanical devices. Background should include design, fabrication and testing—and must have project engineering experience of increasing complexity.

THERMODYNAMICS

PhD or Masters in Mechanical or Chemical Engineering with minimum 10 years in the research, development and design field concerning thermodynamics and energy conversion projects.

To creative engineers of marked ability, who wish to deepen their job skills through challenging, diversified work in the above fields, the Mechanical Laboratory offers excellent salaries, periodic merit reviews, liberal tuition reimbursement plan and a comprehensive benefits program including relocation expenses.

Send resume including salary particulars to **Paul Luke**, Personnel Administrator, **Dept. M-2**

RESEARCH & DEVELOPMENT DIVISION

American Machine & Foundry Company

689 Hope Street — Springdale, Connecticut

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Immediate opening in corrosion research laboratory of large metal company. To plan and conduct basic and applied research on corrosion of ferrous and nonferrous alloys. Prefer graduate degree, with several years' experience in corrosion research. Position offers opportunity for advancement and publication of research. Send complete resume stating salary requirement.

Address CA-6859, care of "Mechanical Engineering."

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VALVES and mechanisms for high pressure-temperature services including nuclear power. Contact R. A. Kampwirth, Edward Valves, Inc., 1200 W. 145th St., East Chicago, Indiana.

INSTRUMENTS and electronic pneumatic control systems for power and process industries. Contact R. J. Waggett, Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Illinois.

Subsidiaries of Rockwell Manufacturing Company

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Experience: Five or more years' experience in design and development of high pressure piston pumps and motors for hydraulic power transmission systems used in aircraft, industrial and mobile application.

Duties: 1. To aid in initiating and carrying out an R&D program for development of pumps and motors for advanced hydraulic power transmission development programs.

2. To supply design know-how on pumps and motors and/or advanced power transmission systems.

3. Set up and carry out R&D program for development of pumps and motors for mobile equipment including industrial and defense products.

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Mr. L. J. Borkowski

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Borg-Warner Corporation

Des Plaines, Illinois

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Excellent opportunity with fast-growing company.

Address reply to Mr. H. E. Beane, Vice President, The Bristol Company, Waterbury 20 Connecticut.

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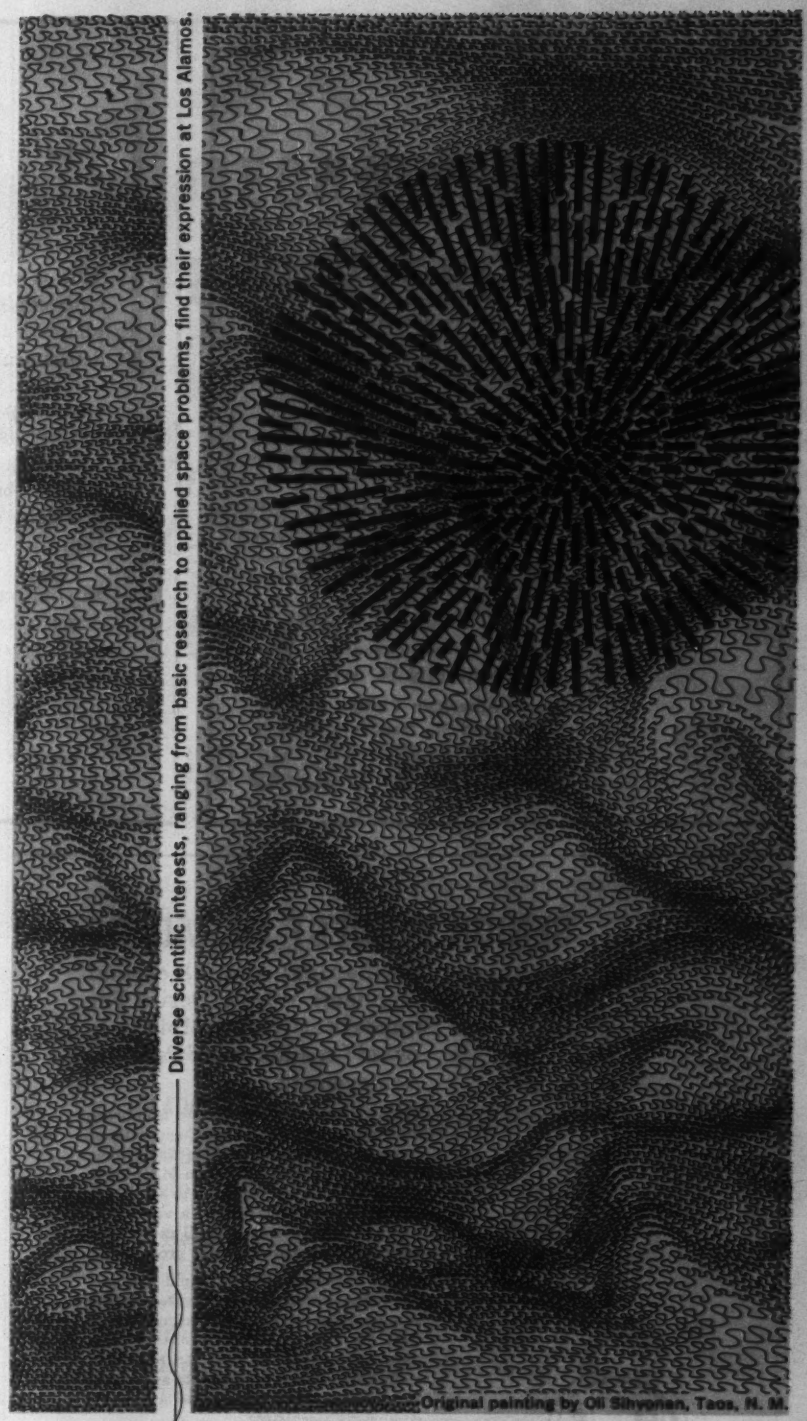
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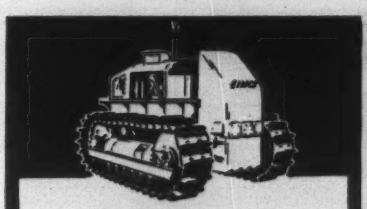

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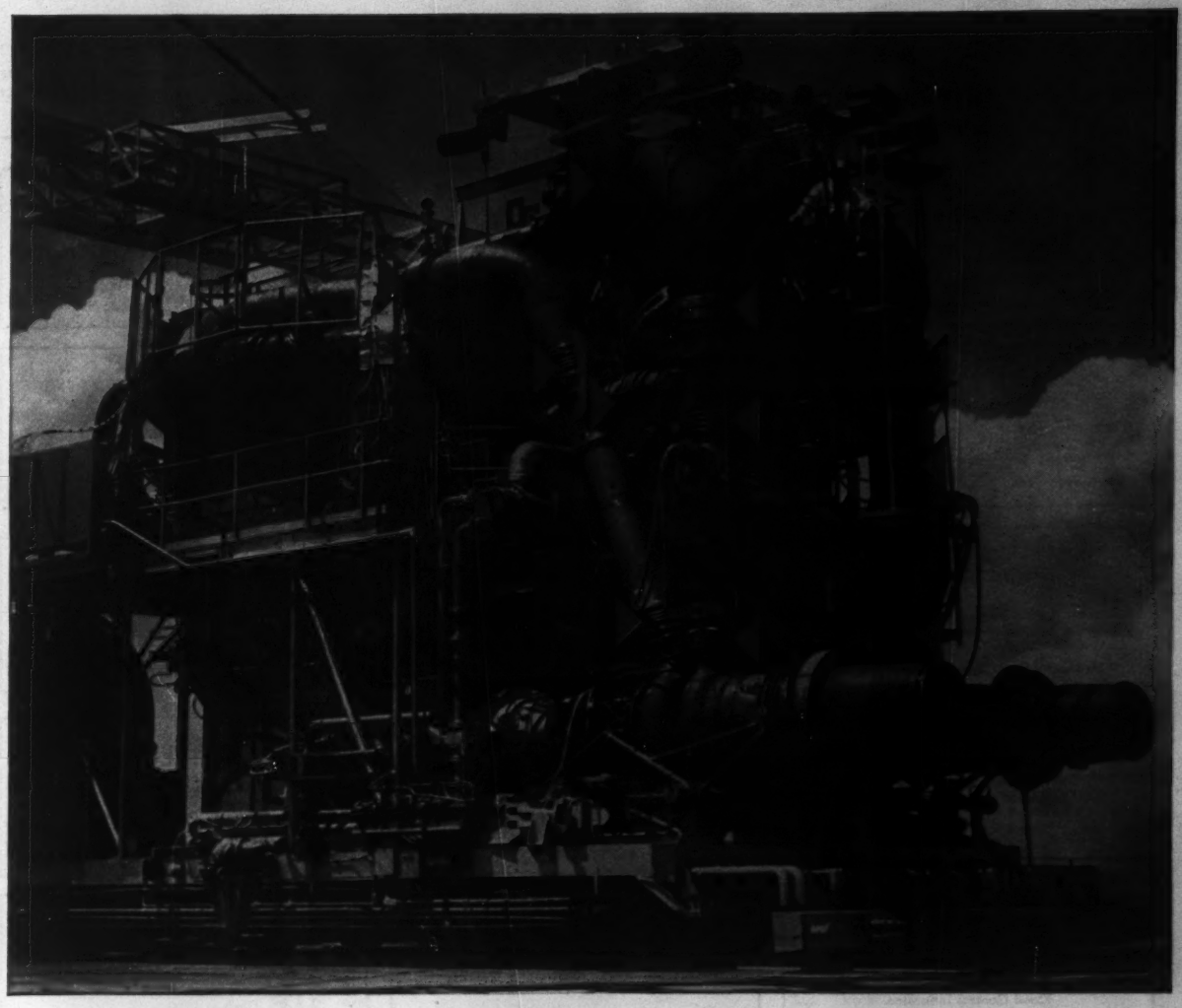

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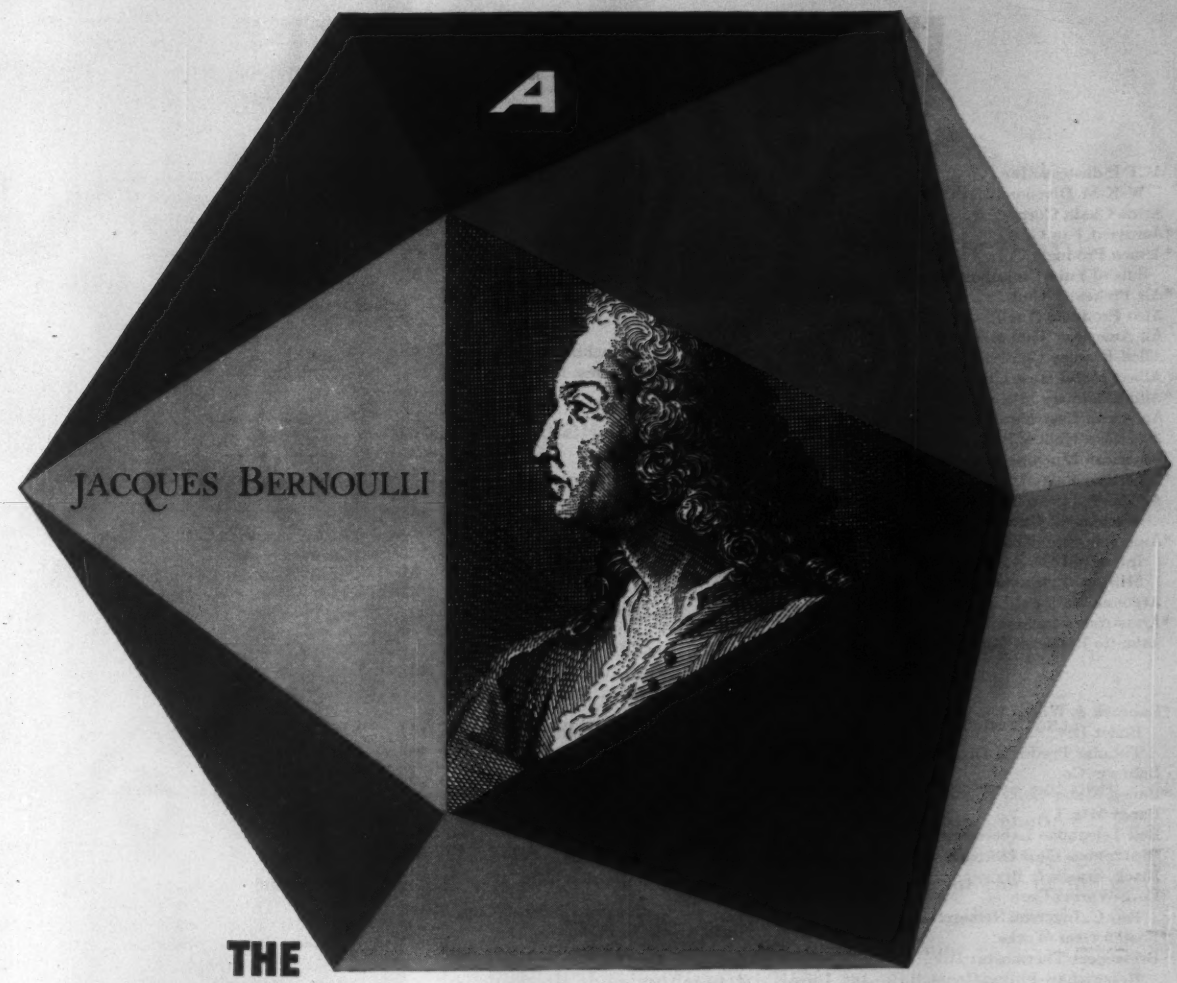

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INDEX TO ADVERTISERS

ACF Industries (Inc.)
W-K-M Division ..... 3rd Cover
Acme Chain Corp. 165
*Aerovent Fan Co. 191
*Aimco Products Corp.
Sub. of Yuba Consolidated Industries 28
*Air Preheater Corp. 34
Alco Products (Inc.) 196
All American Tool & Mfg. Co. 178
Allen-Bradley Co. 45
Allied Metal Hose Co. 169
*Allis-Chalmers Mfg. Co. 195
American Cast Iron Pipe Co. 186
American Hollow Boring Co. 174
American Machine & Foundry Co. 195, 198
*American Pulverizer Co. 169
ASME Publications 184
Mechanical Catalog 168
*American-Standard
Industrial Div. 17–20
Military Products Div. 150, 151
Argonne National Lab. 180, 181
*Armstrong Machine Works 42
Atlantic Research Corp. 193

*Babcock & Wilcox Co.
Boiler Div. ..... 2nd Cover
Tubular Products Div. 4
Bahnson Co. 190
*Bailey Meter Co. 49
Barco Mfg. Co. 159
Bell Telephone Laboratories 203
Bituminous Coal Institute 10, 11
Black, Sivalls & Bryson 23, 187
*Borg-Warner Corp
Roy C. Ingersoll Research Center .. 196
*Boston Gear Works 2
Bridgeport Thermostat Div.,
Robertshaw-Fulton Controls Co. .. 166, 167
*Buell Engineering Co.
Northern Blower Div. 152
*Buffalo Forge Co. 47
Bundy Tubing Co. 44

Carborundum Co. 206
Cash, A. W., Valve Mfg. Co. 164
Chace, W. M., Co. 158
Cleveland Worm & Gear Co. 48
Curtis Mfg. Co.
Refrigeration Div. 172

Dresser Industries (Inc.)
Pacific Pumps (Inc.) 27
Dudek & Bock Spring Mfg. Co. 177
du Pont, E. I. de Nemours & Co. 199

Eagle Pencil Co. 176
Eastman Kodak Co. 179
Eimco Corp. 199
*Erie City Iron Works 41

*Falk Corp. 29
*Flexonics Corp.
Sub. Calumet & Hecla 1
*Foster Wheeler Corp. 6, 7
Foxboro Co. 24

General Motors Research Labs. 205
General Radio Co. 189

Helitork
Div. of Earle Gear & Machine Co. . 37
Homestead Valve Mfg. Co. 51

*Illinois Gear & Machine Co. 43
International Business Machines 194

*James, D. O., Gear Mfg. Co. 160
Jeffrey Mfg. Co. 22
Jenkins Bros. 146
Johnston Pump Co.
Div. Youngstown Sheet & Tube Co. 155

*Keeler, E., Co. 31
Kellogg, M. W., Co. 32
Keuffel & Esser Co. 21

Los Alamos Scientific Lab. 197

McDonnell & Miller (Inc.) 154
McGraw-Hill Book Co. 183

*Marsh Instrument Co.
Div. of Colorado Oil & Gas Corp. .. 185
Monsanto Chemical Co. 193

National Distillers & Chemical Corp. 193
North American Philips Co. 198

Ohio Gear Co. 149
Ozalid Div.
General Aniline & Film Corp. 30

Pacific Pumps (Inc.)
A Div. of Dresser Industries (Inc.). 27
*Pangborn Corp. 156
*Patterson-Kelley Co. 50
Pittsburgh Lectrodryer Div.
McGraw-Edison Co. 163
Powell, William, Co. 33

Raybestos-Manhattan (Inc.)
Manhattan Rubber Div. 16
Reliance Gauge Column Co. 175
Robertshaw-Fulton Controls Co.
Bridgeport Thermostat Div. 166, 167
Rockford Clutch Div.
Borg-Warner 171
Rust-Oleum Corp. 15

St. Regis Paper Co. 198
*Sandusky Foundry & Machine Co. .. 182
Sly, W. W., Mfg. Co. 170
*Southwest Products Co. 177
Spraying Systems Co. 178
Stephens-Adamson Mfg. Co. 26
*Struthers Wells Corp.
Div. Titusville Iron Works Co. 38, 39

*Terry Steam Turbine Co. 46
Thomas Flexible Coupling Co. 164
Timken Roller Bearing Co. ..... 4th Cover
*Titusville Iron Works Co.
Div. Struthers Wells Corp. 38, 39

Uni-Flex Mfg. & Engrg. (Inc.) 25
United States Graphite Co.
Div. Wickes Corp. 8, 9
United States Pipe & Foundry Co. 12, 13

*Vogt, Henry, Machine Co. 35

W-K-M Div. of
ACF Industries (Inc.) ..... 3rd Cover
Waldes Kohinoor (Inc.) 40
*Westinghouse Electric Corp.
Atomic Power Dept. 148
Bettis Atomic Power Lab 188
*Wheeler, C. H., Mfg. Co. 192
Whitney Chain Co.
Sub. Foote Bros. Gear & Mach. Corp. 157
Whiton Machine Co. 173
*Wickes Boiler Co.
Div. Wickes Corp. 52
Winsmith (Inc.) 153

*Yarnall-Waring Co. 145
Yoder Co. 14
York Corp.
Sub. Borg-Warner Corp. 36
*Yuba Consolidated Industries (Inc.) .. 28

*Zallea Bros. 201
Zonolite Co. 191

* The asterisk indicates that firm has product catalog in the 1960 Mechanical Catalog.

Your attention is directed to

Keep Informed Section 147–178
Consulting Service 202
Opportunities 193–200
Engrg. Soc. Personnel Service ... 140
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On the riddle of rolling friction

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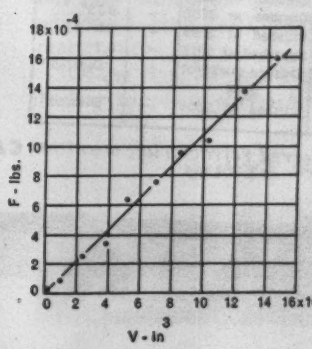
Warren, Michigan



Relationship of rolling force to elastically stressed volume.

CARBORUNDUM'S Data sheet

TECHNICAL INFORMATION ON SPECIAL REFRACTORIES

Comparative tests help determine

HOT STRENGTH

Studies of hot strength — or the ability to stand up under load at elevated temperatures—are a primary requirement in the selection and application of practically all refractories. The need for accurate data becomes all the more important as operations move to higher and higher temperatures, or where long periods of soaking heats are involved.

Information available from Carborundum includes compressive load tests, covering short duration and sustained periods, to indicate load-carrying capacity. Transverse load tests also provide valuable information — particularly, for applications where large spans of refractory shapes are unsupported or must carry a heavy furnace charge.

Engineering assistance can be given in evaluating the various factors affecting operation and in applying Carborundum's refractories to your job. Please feel free to ask any questions that may occur to you.

SUSTAINED LOAD TESTS

	Load, Psi.	Deformation After 100 Hr., % Temperature, Deg. F. 2192	2462	2732
Fireclay	6.25	0.30	3.9	—
	12.5	0.23	4.3	—
	25	0.32	11.3	—
	50	0.46	over 10.3	—
Semi-silica	6.25	—	1.19	—
	12.5	—	3.14	—
	25	—	5.03	—
	50	1.19	—	—
Silica	6.25	—	—	—
	12.5	—	—	Nil
	25	—	—	0.13
	50	—	—	0.25
High-alumina-fireclay	6.25	—	2.8	—
	12.5	—	2.4	—
	25	0.87	7.7	—
	50	1.30	9.9	—
Alfrax® "K" brick	6.25	—	+0.20	2.51
	12.5	—	+0.04	3.73
	25	—	0.25	8.68
	50	—	1.08	10.58
Monofrax® H brick	6.25	—	—	—
	12.5	—	—	—
	25	—	—	—
	50	—	—	0.36
Carbofrax® brick	6.25	—	—	0.40
	12.5	—	—	0.40
	25	—	—	0.58
	50	—	—	0.78

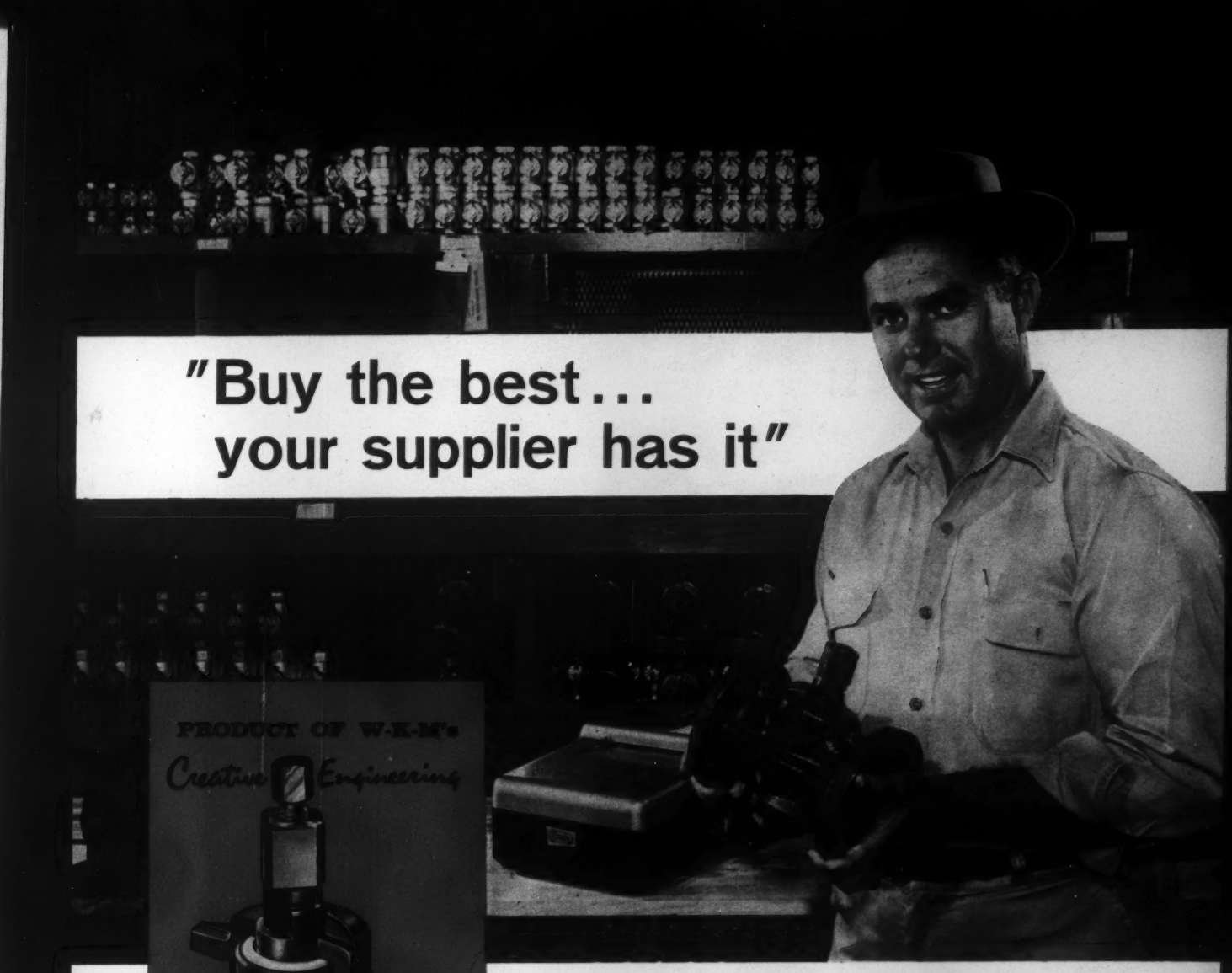
Comparison of hot strength of various refractories held at 3128 F for 1½ hrs under load of 25 psi shows CARBOFRAX® silicon carbide brick undeformed (extreme left) and MULLFRAX® electric furnace mullite brick (second from left) with less than 1.4% contraction. Other samples shown are commonly-used refractories in various stages of deformation. One on the right failed at 3002F.

HIGH TEMPERATURE, SHORT DURATION LOAD TESTS

Refractory	Max. Expan. at Temp. °F	Start Rapid Contr. °F	Hold Temp. Max. °F	Hold Temp. Aver. °F	% Linear Cold Contr.	Cold Length
Mullite brick	2561-2795	2867	3137	3128	14.3	7.75"
Mullfrax® W brick	2552-2768	None	3128	3119	1.31	8.943"
Carbofrax® A brick	2534-2714	3092	3146	3137	0.78	8.915"
Chrome magnesia brick	2597-2741	2975	Crushed at 3002		—	"Sheared"
Fireclay brick	2642-2660	2732	Crushed at 3002		—	6.75"
Fireclay brick	2462	2561	Crushed at 2993		—	6.6"
High alumina brick	2561-2624	2642	Squashed at 3011		—	6.7"
Silica brick	2795-2903	None	Crushed sharply at 2948		—	"Sheared"
Magnesia brick	2327	2507	Crushed at 2552		—	"Sheared"

Write today for your free copy of "Super Refractories by Carborundum." The address: Dept. ME-20, Refractories Division, Perth Amboy, New Jersey.

For engineered refractories, count on **CARBORUNDUM®**



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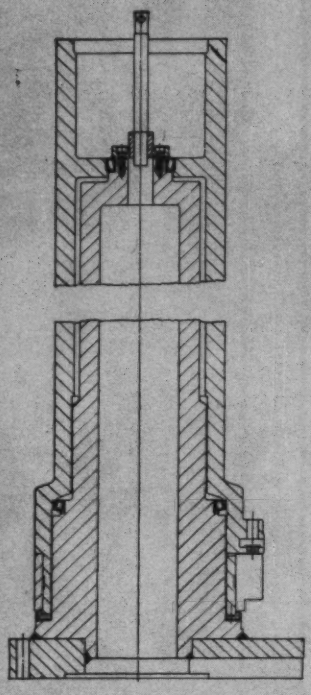
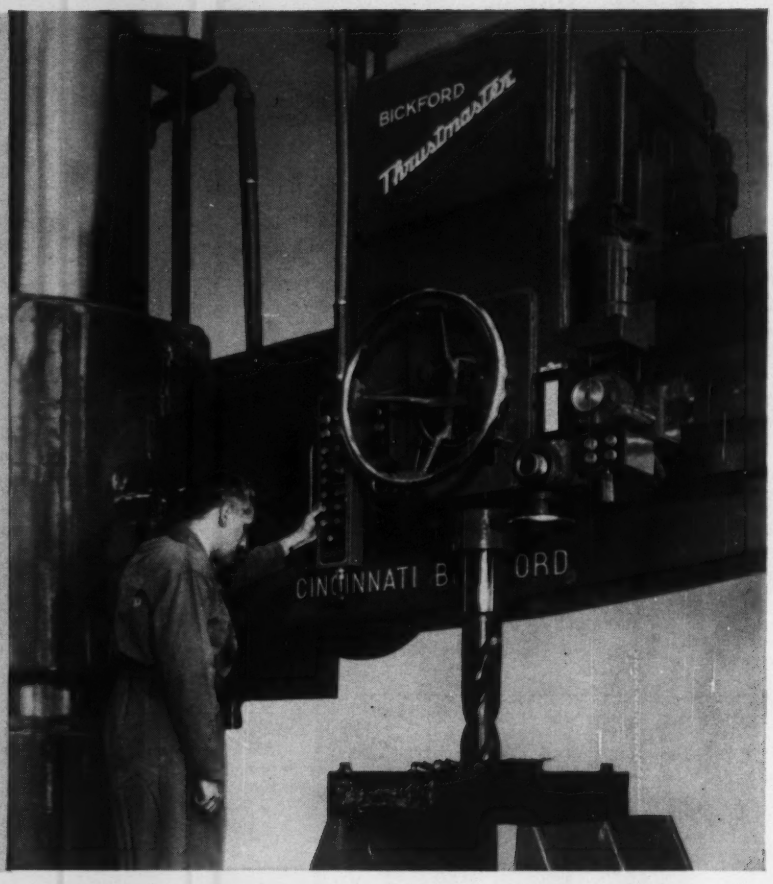


How **CINCINNATI-BICKFORD** mounts column of "Thrustmaster" radial drill on Timken bearings to assure rigidity.



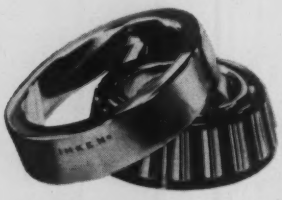
World's most powerful radial drill uses 41 Timken® bearings to assure rigidity, handle extreme loads

WEIGHING 80,000 lbs. and driven by a 50 h.p. electric motor, this 34-inch diameter column "Thrustmaster", by Cincinnati-Bickford Division of Giddings & Lewis Machine Tool Company, is the world's most powerful radial drill. To resist stresses and reduce arm deflection, the column is mounted on large pre-loaded Timken® bearings—one at the top, one at the bottom. They give the column and sleeve the rigidity of a single piece, resulting in greater accuracy and longer tool life, with higher speeds and coarser feeds. And 39 more Timken tapered roller bearings are used in the drill head. Timken bearings assure better performance because they . . .

1) *Take all loads.* Their taper lets Timken bearings take *both* radial and thrust loads. And full-line contact between rollers and races gives extra load-carrying capacity. 2) *Practically eliminate friction.* Timken bearings are geometrically designed and precision-manufactured for true rolling motion.

And Timken bearing service from graduate engineer salesmen qualified to work with your purchasing, engineering and production people is an *extra* advantage. It's service, backed by research and testing facilities unique in the bearing industry.

That's why Timken bearings give you: *1) Quality you can take for granted.* 2) *Service you can't get anywhere else.* 3) *The best-known name in bearings.* 4) *The pace setter in lower bearing costs.* Specify Timken bearings for the machines you use or buy. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.*



BETTER-NESS rolls on

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